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1985 ANNUAL REVIEW

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1985 ANNUAL REVIEW

Special Report — March 1986

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MARKET DEVELOPMENTS

NATURAL URANIUM SUPPLY, DEMAND AND PRICES

Overview

The spot market for uranium exhibited two distinctly different trends in 1985. The first half of the year witnessed the continuation of the lingering price decline that had been in effect almost continuously for the past two years. The first six Nuexco Exchange Values in 1985 were all lower than any published in the previous ten-year period, and April's value of $14.25 was the lowest since October 1974. As in recent years, this evidence of market weakness was attributable to slack demand, forced inventory liquidations, and the continued perception among both producers and consumers that large, newly discovered high-grade deposits could be brought into production as needed without a precipitous rise in prices. Beginning in July, however, the majority of bids, offers, and transactions gave persistent indications of market firming. That trend continued through the end of the year, and spot prices began a slow rise that has continued to date. This rise, only the second sustained price recovery since the all-time high of $43.40 in mid-1978 and the mid-1983 peak of $24.00, took the Exchange Value to $17.00 by the end of 1985.

Several important developments during the year influenced the mid-year turnaround.

1. A number of the highly visible distress sellers of inventory liquidated their material early in 1985, leading some market observers to conclude that the seemingly inexhaustible supply of bargain-priced material hanging over the market was in fact evaporating.

2. The US dollar weakened considerably from its record highs against a number of other currencies. As a result, many non-US buyers witnessed uranium prices falling in their own currencies during 1985, prompting many to become active in spot-market purchasing.

3. As the year progressed, a large number of utilities entered the longer-term market, soliciting proposals for some 40 million pounds of U_3O_8 equivalent for delivery in the late 1990s and 1990s. Some found that prices contained in offers for future delivery, when discounted to 1985 dollars, were still substantially higher than 1985 spot prices. Some of these utilities decided to buy uranium on the spot market and hold it in inventory until needed, effectively using spot uranium to satisfy future needs, thereby increasing near-term demand.

4. The US Department of Energy's (DOE) Utility Services enrichment contract (USEC) was declared null and void by a US District Court in September, causing widespread uncertainty regarding the future of the contract. The replacement of fixed-commitment type enrichment contracts by the requirements-type USEC had eliminated millions of pounds of artificially created demand associated with utilities' needs to fill excess DOE SWU contract commitments.

5. Secretary of Energy John Herrington declared the US uranium industry to be non-viable, leading to the increased speculation that the US government might impose limitations on the importation or enrichment of non-domestic uranium.

The First Half

The Nuexco Exchange Value declined from $15.25 in December 1984 to the ten-year low of $14.25 in April 1985 (Table 1). During early 1985, as during most of 1984, the supply of low-cost inventory continued to exceed the highly discretionary demand of a few buyers. Increased competition between sellers for the few available sales opportunities as they arose contributed to the downward pressure on prices. As had been demonstrated in previous market lows, both the volume of material purchased and the number of transactions increased dramatically in the face of extremely low prices in the first quarter of 1985. Over 20 transactions totaling almost five million pounds of uranium were reported from January through March 1985, with most buyers purchasing about one reload's requirements. This level of transaction volume continued through the second quarter of 1985 as prices remained low.

As prices fell to the $14.25 level in April, discretionary buyers became motivated to purchase from the distress sellers forcing material on the market. However, since virtually *all* demand in the market at the time was discretionary rather than fundamental, they tended to withdraw as soon as they had obtained material at bargain prices, or when any upward market trend became noticeable. Prices then stabilized at the $15.00 level for two more months. The sustained price rise hoped for by many producers did not occur because enough inventory material remained on the market at the time, and the rise from $14.25 to $15.00 drew even more material into the market.

The supply and demand figures presented in Table 2 demonstrate these trends. Uranium available for supply reached a peak of about five million pounds U_3O_8 equivalent in February. In April and May, despite the volume of material sold, uranium supply remained relatively high, slightly below three million pounds. It stayed at that level through August. Conversely, buyer demand decreased markedly in that period, from 4.1 million pounds in March to under one million pounds in May, remaining at that level until November, well after prices had firmed.

The Weakening Dollar

Throughout 1984, the US dollar had risen strongly in the international currency markets, contributing to a large trade

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Table 1

1985 NATURAL URANIUM MARKET VALUES

Determined as of the Last Day of the Month	Published in Report Number	Exchange Value[1] (per lb. U_3O_8)	UF_6 Value[2] (per kgU in UF_6)	Conversion Value[3] (per lb. U in UF_6)	Loan Rate[4] (per annum)
January	198	$15.00	—	$1.00	6%
February	199	$15.00	—	$1.00	5%
March	200	$15.00	—	$1.00	5%
April	201	$14.25	$40.50	$1.50	5%
May	202	$15.00	$42.50	$1.50	5%
June	203	$15.00	$42.50	$1.60	5%
July	204	$15.75	$44.00	$1.60	5%
August	205	$16.00	$44.50	$1.60	5%
September	206	$16.00	$44.50	$1.60	5%
October	207	$16.50	$46.00	$1.60	5%
November	208	$16.75	$46.00	$1.60	5%
December	209	$17.00	$47.00	$1.60	5%
Annual Average		$15.60	$44.17	$1.43	5.1%

[1]The *Exchange Value* is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month indicated.
[2]The *UF_6 Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.
[3]The *Conversion Value* is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month indicated.
[4]The *Loan Rate* is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month indicated.

Table 2

1985 SPOT AND NEAR-TERM[1] SUPPLY AND DEMAND FOR NATURAL URANIUM
(Active[2] inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Uranium Supply[3] (Available for Sale)	Uranium Demand[3] (Inquiries to Purchase)	Spot and Near-Term Supply/Demand Ratio	Exchange Value (per lb. U_3O_8)
January	198	4.2	1.3	1.3	$15.00
February	199	5.3	2.3	2.3	$15.00
March	200	4.3	4.1	1.0	$15.00
April	201	2.7	1.4	2.0	$14.25
May	202	2.7	0.9	2.8	$15.00
June	203	3.5	1.3	2.7	$15.00
July	204	3.0	0.5	6.7	$15.75
August	205	3.3	1.2	2.8	$16.00
September	206	2.1	1.1	1.9	$16.00
October	207	3.2	0.9	3.6	$16.50
November	208	3.6	2.3	1.6	$16.75
December	209	3.6	2.3	1.5	$17.00
Annual Average		3.5	1.6	2.1	$15.60

[1] For delivery within one year.
[2] Involving competitive price, terms, and other conditions.
[3] Millions of pounds U_3O_8 equivalent.

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imbalance in the USA. US goods on international markets were not attractive because of the strong dollar, while in the USA, non-US goods could be purchased at extremely low prices. By January 1985, the US dollar had peaked with record highs against many non-US currencies. Due to various factors, some stemming from efforts to reduce the US trade imbalance, in February 1985 the dollar began a steady decline against the Japanese yen and many European currencies. (Certain European currencies are linked by the European Monetary System (EMS[1]), so changes in the dollar value of the French franc and the West German mark, for example, have been virtually identical.) The result, illustrated in Figure 1, is that uranium prices in many consumer countries declined sharply in 1985, even when prices expressed in US dollars rose during the second half of the year. This trend improved the market for many non-US uranium buyers, but worsened the condition for European sellers. Many non-US buyers continued to purchase available material even at slightly higher dollar prices because effective prices were stable or even falling in their own currencies. Table 3 shows the change in currency per US dollar for various foreign currencies over a period from the end of 1984 to the end of 1985. Table 4 shows the change in Nuexco Exchange Value for various foreign currencies over the same period of time.

The Second Half

The second half of the year was typified by a slow firming of the market, and the Exchange Value moved from $15.00 in July to $17.00 at the end of December. Two developments at the end of September launched a period of market uncertainty that persisted throughout the remainder of 1985.

— The federal court ruling that the USEC was invalid.

— The declaration by the Secretary of Energy that the US production industry was not viable. Occurring almost simultaneously, those two events fueled speculation that:

1. Restrictions on the importation or enriching of non-US uranium would be imposed by the US government, and would thereby create a two-tiered market, i.e. one in which US-origin uranium would command a substantial premium.

2. The invalidation of the USEC would either force DOE and its customers to revert to fixed-commitment contracts, or would free DOE's customers to sign with Eurodif or Urenco, or seek secondary market sources.

The cumulative market effect of these uncertainties created upward pressure on natural uranium prices. Most sellers became confident that higher prices would prevail soon anyway, and

[1]The EMS is an agreement among several European countries, including Belgium, the Federal Republic of Germany, France, Italy, and the Netherlands, that keeps the exchange rates among the various participating currencies within a narrow trading range, except in cases of official devaluations. For example, Italy devalued the lira in the fall of 1985.

Figure 1

RATIO OF 1985 EXCHANGE VALUES TO EXCHANGE VALUE OF FEBRUARY 28, 1985 MEASURED IN SELECTED CURRENCIES.

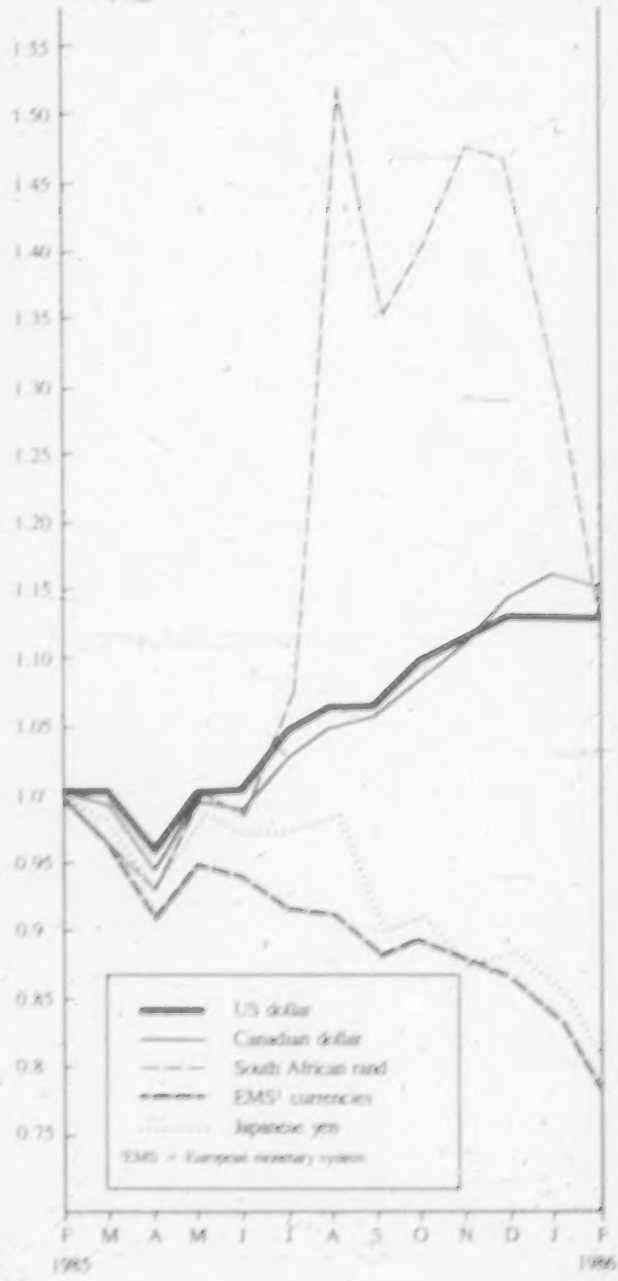

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Table 3

YEAR-END EXCHANGE RATES[1]
(Currency per US dollar)

Country (currency)	As of Dec. 28, 1984	As of Dec. 31, 1985	Percent Change
Australia (dollar)	1.20	1.47	+23
Belgium (comm. franc)	62.97	50.28	−20
Canada (dollar)	1.32	1.40	+ 6
Finland (markka)	6.52	5.42	−17
France (franc)	9.65	7.55	−22
FRG (mark)	3.15	2.46	−22
Italy (lira)	1,933	1,677	−13
Japan (yen)	250.10	200.75	−20
Netherlands (guilder)	3.55	2.77	−22
South Africa (rand)	1.97	2.58	+31
Spain (peseta)	172.95	154.20	−11
Sweden (krona)	8.96	7.59	−15
Switzerland (franc)	2.59	2.08	−20
UK (pound)	0.66	0.70	−19
US (dollar)	1.00	1.00	0

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

Table 4

YEAR-END EXCHANGE VALUES EXPRESSED IN SELECTED PRODUCER AND CONSUMER CURRENCIES[1]

	per Pound U3O8 in Concentrates		
Country (currency)	As of Dec. 31, 1984	As of Dec. 31, 1985	Percent Change
Australia (dollar)	18.37	24.92	+36
Belgium (comm. franc)	960.33	854.70	−11
Canada (dollar)	20.13	23.78	+18
Finland (markka)	99.48	92.19	− 7
France (franc)	147.20	128.40	−13
FRG (mark)	47.99	41.87	−13
Italy (lira)	29,480	28,509	− 3
Japan (yen)	3,814	3,413	−10
Netherlands (guilder)	54.08	47.16	−13
South Africa (rand)	29.99	43.87	+46
Spain (peseta)	2,638	2,621	− 1
Sweden (krona)	136.53	128.98	− 5
Switzerland (franc)	39.54	35.31	−11
UK (pound)	13.10	11.82	−10
US (dollar)	15.25	17.00	+12

[1]Currency exchange rates from the *Wall Street Journal* of the date indicated.

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began raising their spot and near-term offering prices. Many buyers, while sharing the sense that prices could indeed move higher in the near term, nonetheless largely resisted the price rise and left the market, confirming the discretionary nature of their demand. Meanwhile, those sellers that were content to wait kept their offering prices firm, rather than actively pursuing potential buyers. The result was a sharp decline in transaction volume. In the last four months of 1985, only 2.8 million pounds were sold on the spot market.

The decision by a number of utilities to solicit long-term offers during the final months of 1985 contributed additional upward pressure on prices. Many such utilities discovered that the offers they received contained prices for further delivery that were much higher in constant dollars than present spot prices. Some buyers chose to do nothing, hoping for better offers later. But some decided to purchase additional inventory for later use, revising upward the prices they were willing to pay to procure the material on the spot market.

UF_6 Value

In May 1985, Nuexco began publishing a value for natural uranium hexafluoride. The UF_6 Value was defined as "Nuexco's judgment of the price at which transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated." Table 1 lists the UF_6 Value for each of the nine months in which it was published. The addition of this value was the cumulative result of many factors, including the following:

1. Over half of the natural uranium sold on the spot/near-term market in 1984 (as reported by Nuexco) involved UF_6, and nearly two-thirds of the material sold in the longer-term market in 1984 involved UF_6. In addition, transactions involving UF_6 comprised more than half of the total quantity of natural uranium sold in the first four months of 1985.

2. When the UF_6 Value was introduced in May 1985, demand for UF_6 was approximately equal to the demand for concentrates.

3. Two apparently contradictory pricing situations for conversion services had been present in the market for some time. Buyers preferring UF_6 or conversion services had been forced to pay premiums in order to do business with discretionary sellers of UF_6 or conversion services. Conversely, UF_6 sellers were forced to discount the value of the conversion component in their material in order to do business with buyers that preferred natural uranium concentrates. Therefore, at the time the value was introduced, the value of UF_6 was slightly less than the algebraic sum of the price of U_3O_8 plus the price of secondary market conversion.

The publication of a UF_6 Value presented a clearer and more complete analysis of actual market prices for nuclear fuel by eliminating misconceptions stemming from the assumption that the price of the U_3O_8 component and the conversion component would always equal the value of UF_6. In practice, the UF_6 Value rose at about the same rate as the Exchange Value during 1985. In the first few months of its publication, the UF_6 Value remained close to the algebraic sum of the Exchange Value and Conversion Value. As the supply of UF_6 increased in the second half of the year and some sellers chose to discount UF_6 in order to sell it on short notice, the value reflected the increased supply of UF_6 by dropping as much as $1.00 (per KgU in UF_6) below the algebraic sum of the Exchange and Conversion Values.

Conversion Value

In general, the conversion market stabilized in 1985, as holders of large excesses of conversion services disposed of their material and prices leveled by mid-year. Only three conversion sellers remained at the end of the year, and none of them indicated strong motivation to sell. Buyers having unfilled near-term needs for conversion services were relatively active throughout the first three quarters. Moreover, many buyers normally covered by long-term conversion contracts found that available secondary market prices for conversion could provide enough incentive to justify their cancellation of deliveries under contracts with primary converters. The conversion services then could be replaced in the secondary market. Consequently, the Conversion Value rose from $3.00 in January to $4.50 in April and reached $5.50 in June, where it remained for the rest of the year. (Table 1 lists the Conversion Values for each month of 1985, and Table 5 summarizes the supply and demand of secondary market conversion services for each month of 1985.) Active supply of conversion services rose steadily in the first half of the year, but generally declined as the price stabilized at $5.50. Demand fluctuated in the first half of the year, as discretionary buyers entered and exited the market, but in later months, demand was virtually nonexistent.

Loan Rate

In March, the Loan Rate declined from six percent to five percent per annum, as a potential lender began offering a substantial quantity of material at that rate. Thereafter, the Loan Rate did not change. The loan market remained quite dormant throughout the year, as in 1984. Nuexco was aware of only a few prospective borrowers during the entire year. Several potential lenders continued to offer substantial supplies of material (each on the order of two million pounds) for loan. In the past few years, however, low uranium prices in the spot and near-term markets have made purchasing more attractive than borrowing, the need for payback and credit arrangements has largely discouraged many potential borrowers from entering loan agreements. Table 5 lists the supply and demand for natural uranium loans in 1985.

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Table 5

1985 SUPPLY AND DEMAND FOR SECONDARY MARKET CONVERSION[1] AND NATURAL URANIUM LOANS[2]
(Active[3] inquiries as reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Conversion Supply (Thousands of pounds U as UF_6)	Conversion Demand	Loan Supply (Thousands of pounds U_3O_8 equivalent)	Loan Demand	Exchange Value
January	198	0	390	0	0	$13.00
February	199	300	255	0	0	$15.00
March	200	110	255	0	0	$25.00
April	201	550	290	0	250	$14.25
May	202	1,600	965	0	300	$15.00
June	203	1,660	965	0	300	$25.00
July	204	360	425	0	300	$25.75
August	205	325	525	2,300	500	$16.00
September	206	100	0	2,000	500	$16.00
October	207	0	0	2,000	0	[illegible]
November	208	0	0	2,000	0	$16.75
December	209	300	0	2,000	0	$17.00

[illegible] delivery within three years.
[2]Data refer to spot and near-term demand, i.e. material to be delivered in the maximum within one year.
[3]Involving competitive price, terms, and other conditions.

Analysis of Uranium Sales Transactions

During 1985 Nuexco reported 70 transactions involving the spot or near-term sale of approximately 15.5 million pounds equivalent U_3O_8. This quantity was divided between U_3O_8, natural UF_6, and low-enriched uranium. Table 6 shows a breakdown of 1985 spot or near-term uranium sales transactions listed in the Nuexco Monthly Report.

As in past years, Nuexco's reporting of nuclear fuel transactions is subject to some limitations. Certain transactions may not have been reported because of one or more of the following circumstances.

1. Nuexco chooses not to report transactions (or certain information about published transactions) if the reporting of such information would jeopardize client confidentiality.

2. Transactions of which Nuexco was not aware, or those about which sufficient reliable information could be ascertained, are not reported.

3. Because of the subjective nature of Nuexco's judgments, some agreements between parties may be reported as transactions only to collapse later during final negotiations. An agreement may be judged a transaction as soon as the parties verbally agree, as late as contract signing, or even later, depending on Nuexco's confidence that the agreement will be concluded. In addition, different market observers, even if given identical information, can reach different conclusions on the question of when a negotiation becomes a transaction that merits reporting.

Table 6

TRANSACTIONS: SPOT OR NEAR-TERM URANIUM SALES[1] REPORTED BY NUEXCO IN 1985
(Thousands of pounds U_3O_8 equivalent)

SELLERS	BUYERS		
	Utilities	Producers	Others
Utilities	3,500	0	1,050
Producers	4,675	1,725	1,640
Others	2,255	340	300

[illegible] not include transactions which fall into one or more of the following categories:

a. Transactions which took place in 1984 but were reported in 1985.
b. Transactions which involved spot lots and fuel.
c. Transactions of which Nuexco was not aware.
d. Transactions that Nuexco was aware of but chose not to report, either to protect client confidentiality or because Nuexco was not satisfied with the reliability of the information, and/or
e. A negotiation which has not advanced to such a degree that Nuexco would judge it a completed transaction. Because of the subjective nature of Nuexco's judgments, some pending negotiations are later [illegible] reported as transactions only to fall through later. In these cases, the transaction was omitted from this table.

[1]Finally, a transaction is not a delivery of material, and options or non-deliveries from old transactions are not regarded as transactions.

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4. Delivery of material under old contracts, new deliveries or the exercise of options for additional material under old contracts are not regarded as new transactions. Similarly, renegotiations of old contracts are not included as new transactions.

5. The analysis of 1985 transactions did not include those which took place in 1984 but were reported in early 1985, as well as transactions involving material other than U3O8 concentrates, natural UF6, or low-enriched uranium.

Of the 70 uranium sales transactions reported in 1985, 46 involved U3O8, 21 involved natural UF6, and three involved low-enriched uranium. In terms of the pounds of material delivered (or to be delivered), approximately 42.4 million pounds (87 percent) consisted of concentrates, and 4.9 million pounds U3O8 equivalent (13 percent) consisted of natural UF6. The foregoing amounts incorporate some data refinements made since the transactions were first published.

The overwhelming majority of buyers in 1985 transactions were utilities, both in terms of the number of transactions and the volume of material. Utilities contracted for two-thirds of the material sold in 1985. The sellers, however, were rather evenly distributed between producers, utilities, and others, including trading companies, fabricators and government entities. Of the material purchased by utilities in 1985, about 45 percent came from producers, 35 percent from other utilities, and about 20 percent from other sellers. Inventory liquidation and redistribution by utilities — one of the more significant downward pressures on the Exchange Value in 1985 — resulted in a total of 3.5 million pounds of uranium changing hands between utilities, and another one million pounds diverted by utilities (often only temporarily) to other buyers. That 4.5 million pounds of uranium removed [illegible] from utility inventories was almost twice the amount liquidated in 1984.

As in the past several years, producers found that sometimes it is more economical to purchase on the spot market to meet delivery requirements than to continue high-cost production operations. Thus, producers bought over 2 million pounds of uranium on the spot market in 1985 (about 13 percent of the total), more than doubling the previous year's level of producer buying.

Other entities, mainly trading companies, purchased equally from both producers and utilities, and in turn sold a total of approximately 2.3 million pounds U3O8 equivalent, primarily to utilities. This amount was significantly less than the 3.4 million pounds sold by other entities to utilities in 1984.

The majority of the uranium liquidated by utilities in 1985, regardless of its destination, took the form of UF6. One utility sold a large quantity of U3O8, and two sold enriched UF6. Approximately half of the uranium sold by other sellers consisted of UF6. Although there were 29 sales from producers to utilities, only four of the transactions involved UF6; nevertheless, by weight the UF6 accounted for more than one-quarter of the material sold between these groups.

Transaction Value

Table 7 lists the Transaction Value and its associated parameters for each month of 1985. The Transaction Value is a weighted average of prices paid for natural uranium in spot or near-term transactions of immediately preceding months. The conditions for the calculation stipulate that at least ten transactions, totaling at least 2 million pounds U3O8 equivalent, must be included in each calculation, and that the sample time must be extended as necessary to include these minima. Thus, transactions included in the Transaction Value generally are a subset of those that are listed under the category "Uranium Sales" in the *Current Market Data* section of each Report. Because of the inclusion of transactions from at least the previous two months, the Transaction Value historically trails the Exchange Value when it is moving up or down.

The Transaction Value fell steadily for the first five months of 1985, reacting to the falling prices paid in transactions in those months. The Exchange Value low of $14.25 at the end of April reflected a large producer's liquidation in an already weak market, and the Transaction Value continued to drop, reaching its lowest level ever at the end of May ($14.45). As transactions involving higher prices began to replace those involving prices below the $15.00 level, the Transaction Value rose steadily for the remainder of 1985, trailing the Exchange Value by a range of about $0.50 to $1.00.

Fifty-four 1985 transactions were used in the Transaction Value calculations, and their total quantity was 10.4 million pounds equivalent U3O8. The weighted average price in these transactions was $15.19, approximately $0.40 below the *unweighted* average of 1985 Exchange Values.

Loans and Secondary Market Conversion Transactions

Table 8 lists the single loan transaction and the eight secondary market conversion transactions that were reported in 1985. The overall weakness in the uranium market has contributed to a nearly dormant market for uranium loans over the past several years, a degree of inactivity reflected both in the supply and demand figures and in the general absence of loan transactions.

Discretionary conversion buyers (almost exclusively utilities) occasionally entered the secondary market to engage in transactions, but usually not at what would be termed "bargain" prices. Most of the transactions occurred at or near the prevailing Conversion Value, indicating that sellers of conversion services were not motivated to reduce prices merely to liquidate excess conversion, a situation that continues to characterize the secondary conversion market today.

Table 7

1985 TRANSACTION VALUES[1]
(and associated parameters)

Calculated as of the Last Day of the Month	Report Number	Transaction Value (per Bt. U.Gr.)	Millions of Pounds	Number of Transactions	Number of Months
January	198	$16.20	2.1	14	4
February	199	$15.79	2.3	13	4
March	200	$15.05	2.4	16	3
April	201	$14.90	2.9	20	3
May	202	$14.45	4.6	20	3
June	203	$14.80	4.5	17	3
July	204	$14.94	4.0	17	3
August	205	$15.10	2.4	14	3
September	206	$15.10	2.7	17	4
October	207	$15.75	2.2	13	4
November	208	$15.80	2.9	14	5
December	209	$16.55	2.1	11	3
Annual Average		$15.20[2]	3.0	16	4

[1] The Transaction Value is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
b. At least ten transactions;
c. Transactions involving a sum total of at least 2 million pounds U.Gr.equivalent.
The sample size is extended as necessary to include these minima. Other commissars are converted to US dollars using commission rates in effect on or near the transaction date.
[2] This average is a weighted average.

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Table 8

1985 URANIUM LOANS AND SECONDARY MARKET CONVERSION TRANSACTIONS REPORTED BY NUEXCO

Loan Transactions

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds U3O8 equivalent)	Approximate Price as Percent of Current Loan Rate	Lender	Borrower	Remarks
3451	1985	101-300	100	European Entity	Trader	

Conversion Services
Secondary Market Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds U equivalent)	Approximate Price as Percent of Current U3O8	Seller	Buyer	Remarks
3268	1985	301-600	100	U.S. Utility	European Utility	
3340	1985	50-100	93	U.S. Utility	U.S. Utility	
3332	1985	101-300	100	U.S. Utility	Trader	
3357	1985	101-300	95	W	U.S. Utility	
3429	1987-88	301-600	Undetermined	Fabricator	European Utility	Price escalated from contract signing
3443	1985	301-600	100	Trader	U.S. Utility	
3547	1985	less than 50	90	U.S. Utility	U.S. Utility	
3572	1986	101-300	94	U.S. Utility	U.S. Utility	

W The notation W means that Nuexco either does not know, or that Nuexco has instructed the information to protect client confidentiality.

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SECONDARY MARKET ENRICHMENT SERVICES

Introduction

The secondary market for enrichment services underwent a period of substantial change in 1985. The controversial court decision nullifying the Utility Services enrichment contract (USEC), combined with several broad pronouncements by DOE regarding its market strategy, created worldwide uncertainty over the future of DOE's significant share of the enrichment market. These factors were to dictate the nature of secondary SWU market activity in 1985:

1. In an effort to compete directly with non-DOE SWU suppliers for that portion of its customers' requirements in excess of 70 percent under the USEC, DOE proposed an incentive pricing program for fiscal years 1987 through 1990.

2. DOE announced a series of concrete measures designed to bolster its customers' confidence in DOE's present and future performance and pricing schemes. These measures included a USEC base price reduction to $125 per SWU, a commitment to AVLIS deployment, and the cancellation of the gas centrifuge enrichment plant (GCEP) program.

3. A U.S. District Court ruled that because some of the USEC terms and conditions amounted to changes in the criteria governing enrichment services and the required Congressional approval was not obtained, the contract was null and void.

4. Despite the possible consequences of an invalidated USEC, DOE rapidly sought to increase its market share by inducing more customers to commit to take 100 percent of their enrichment requirements from DOE well into the 1990s. DOE offered a second incentive pricing campaign to its customers, covering FY87-97.

Secondary market activity fluctuated in response to these announcements and uncertainties, but innovative and competitive marketing on the part of the primary enrichers left fewer uncommitments open to secondary market SWU's in 1985. This trend probably will continue as more utilities commit their requirements into the 1990s to the primary suppliers, which will probably continue to lower their prices for enrichment services.

Price Movements

Table 9 presents the various Nuexco SWU Values that were in effect throughout 1985. The Value for DOE-SWU's certifiable in excess generally decreased throughout the year. The Value for FY85 delivery began the year at $112 per SWU and decreased rapidly to $98 per SWU by the third month. This decline was due almost exclusively to vigorous reductions by the few remaining sellers to a fundamental lack of demand. By the end of March, DOE's requirement that it be given 180-day notice of the quantity and assays of the enriched product had expired. Thus, the FY85 market had virtually vanished and buyers began to focus on the FY86 market. (After the 180-day notice expires, it is still possible to conclude transactions for delivery in that fiscal year. Customers could perform a swap involving the exact enrichment percentage that was needed, or could possibly persuade DOE to waive its 180-day notice requirement.)

In late 1984 and early 1985, the Value for DOE SWU's certifiable in excess for FY86 delivery had been expressed in terms of a discount from the FY86 USEC price because the FY86 price had not yet been announced and the preponderance of offers in that period were discount-priced rather than fixed-priced. In April, as the market began acknowledging that the FY86 base price would probably become $125 (which occurred several months before DOE's announcement to that effect), Nuexco began publishing the value as a fixed price rather than a discount.

Most of the market anticipated a lower DOE SWU price for FY86. Furthermore, the favorable response to DOE's incentive price offer for FY87-90 SWU's effectively made FY86 the last year of demand for certifiable SWU. These factors maintained downward pressure on the DOE certifiable price, which fell from $110 per SWU (based on the $125 price and a $15 discount) in January to $78 in November.

Nuexco published two prices for SWU's of "other" origin, i.e. non-certifiable or non-DOE origin SWU, for calendar years 1985 and 1986. The 1985 value for other SWU's was in effect throughout the first six months of 1985, although that market was largely dormant. The little activity that did occur centered around the European primary enrichers Eurodif and Urenco, as they formulated their market strategy in response to the success of DOE's incentive price offer for FY87-90. By June, no demand surfaced and it was evident that the DOE and non-DOE markets had converged. The 1986 value behaved in very much the same way as the DOE-certifiable value. It began the year at $90 per SWU, dropping to $78 at the end of September. Most of the demand had been filled until 1987, and DOE's incentive price offer helped soften the market for calendar year 1986. In addition, as the U.S. dollar weakened during the second half of the year, spot-market sales became less attractive to non-U.S. sellers, primarily the secondary market sellers.

Nuexco began publishing prices reflective of a two-tiered secondary market for enrichment services in November 1983, when, as a result of the modified Interim Sales Contract, it became apparent that the DOE-origin and non-DOE-origin SWU markets were characterized by very different prices. Subsequently, the two-tiered pricing structure changed somewhat, reflecting the importance of certifiability of DOE-origin SWU.

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In the second half of 1985, largely because of the existence of DOE's two incentive pricing initiatives, the two markets began to converge until there was no difference in the prices obtained in either market. Thus, in December 1985, Nuexco returned to a single SWU value.

The DOE Enrichment Program

The dynamics of the enrichment market in 1985 were driven by DOE's two incentive price initiatives and the invalidation of the USEC by a federal court. In addition, DOE released a long-term strategy based on a renewed sensitivity to market forces.

The FY87-90 Incentive Pricing Program. In early April, DOE submitted its first incentive pricing proposal in an attempt to capture the uncommitted portion of its customers' SWU requirements in the FY87-90 period. It included the following conditions:

1. The FY87 and FY88 price was set at $90 per SWU. For FY89 and FY90, the $90 price is to be escalated from October 1, 1988 according to the escalation formula set forth in the USEC.

2. The customer had to commit to buy 100 percent of formerly *uncommitted* requirements under the program.

3. The customer could purchase more than 30 percent of requirements under the program, thereby reducing the nominal USEC percentage below 70 percent—if a termination given before December 31, 1985 had created such an opportunity.

4. The customer could purchase less than 30 percent of requirements under the incentive pricing program, to the extent necessary to accommodate a contract agreed to before February 15, 1985.

5. The customer could select any tails away between 0.2 weight-percent (w/o) and 0.3 w/o at no charge, but only one tails away could be selected per order. This last provision was known as the "free VTAO (Variable Tails Away Option)."

The response to the first offer was overwhelmingly positive; the only exception was the European market where DOE's market share continues to shrink. Thus, DOE had succeeded in capturing most of the uncommitted SWU market for the four-year period, and almost all of that market outside Europe.

September Events

Several important events occurred in September 1985. DOE announced its FY86 SWU prices, including the first announcement of a high-assay charge for enrichment over 10 w/o. It also disclosed its long-term enrichment strategy. Shortly thereafter, a U.S. District Court in Denver ruled that the USEC was null and void. The ruling was a response to one count of a five-count law-suit brought against DOE by a group of U.S. uranium producers. One week later, U.S. Secretary of Energy Herrington declared that the U.S. uranium industry was no longer viable.

Table 9

1985 SWU VALUES

Determined as of the Last Day of the Month	Published in Report Number	DOE-certifiable origin		Non-DOE or non-certifiable origin	
		FY85 Delivery	FY86 Delivery	1985 Delivery	1986 Delivery
January	199	$112	$151	$80	$90
February	199	$102	$250	$80	$88
March	200	$ 98	$250	$80	$85
April	201	—	$95	$80	$85
May	202	—	$90	$80	$85
June	203	—	$90	—	$83
July	204	—	$85	—	$81
August	205	—	$85	—	$81
September	206	—	$85	—	$79
October	207	—	$83	—	$83
November	208	—	$78	—	$78
December	209	—	—	$80[1]	—	—

[1] Represents a discount from USEC base price on delivery.

[2] The SWU Values were changed in Report 208 to one value representing any origin of SWU for delivery within one year.

FY96 DOE SWU Prices. On September 4, DOE announced that the FY96 base price for enrichment services under the USEC would be reduced $30, to $125 per SWU. In addition, DOE set a high-assay charge of $492 per SWU for separative work performed in excess of 77 w/o, effective April 1, 1996. Because of the ceiling price in the USEC, commercial power customers were only marginally affected by the high-assay charge, which has a greater effect on customers such as the Department of Defense.

DOE's Long-Term Strategy. At a meeting with non-US utilities, DOE made its long-term enrichment strategy public, which included the following issues. Some of the announcements had been made in June, but were now combined as part of an overall strategy.

1. In announcing the reduction of the USEC base price to $125, DOE stated that the price might be lowered further to $115, competitive with European enrichers, within four years. DOE also implied that the price might be reduced in the 1990s to a level unrivaled by competitors, culminating in a $90 per SWU price in 2000.

2. DOE predicted that a $250 million cost reduction will be accomplished from 1996 to 1999 at the two operating gaseous diffusion plants at Paducah, Kentucky and Portsmouth, Ohio. DOE plans to improve the economic efficiency of the plants by utilizing off-peak electricity for 50 percent of the off-peak power demand. Finally, DOE announced that the Oak Ridge, Tennessee plant will be placed on standby as a cost-cutting measure, and would resume production if the demand exceeds 14,000 metric tons enriched UF6.

3. DOE decided to proceed with the development of Atomic Vapor Laser Isotope Separation (AVLIS) as the future US enrichment technology. The stated rationale for the decision included the following projections, none of which has been demonstrated to date:

   a. The *potential* for reductions in production costs is high.

   b. The amount of investment required for AVLIS, supposedly no more than $3 billion, may be only half as much as that required to fund an advanced gas centrifuge plant.

   c. A small-scale AVLIS plant should be able to operate as efficiently as a large-scale plant.

Invalidation of the USEC. Judge Carrigan's ruling, first announced September 16 and amended September 19, addressed Count II of a five-count civil suit filed against DOE in December by three US uranium producers — Western Nuclear Inc., Energy Fuels Nuclear Inc., and Uranium Resources Inc. The action had the support of other US producers, many later formed an industry trade group called the Uranium Producers of America (UPA). That body has since assumed the leadership of the group's legal efforts. In Count II, the suit sought a declaration that the USEC is null and void and an order prohibiting DOE from adopting a generic enrichment contract without compliance with the Administrative Procedure Act. (Reports 197 and 206 contain analyses of the events leading up to the filing of the suit and the District Court ruling in September.)

Under the Atomic Energy Act, DOE is required to establish written criteria describing terms and conditions for enrichment services. Furthermore, the adoption of any new criteria requires submission of the contract to Congress for review. In his order, Judge Carrigan stated that the critical issue regarding the USEC was that it "... (amounted) to new criteria governing enrichment." He cited three examples:

1. Existing criteria governing enrichment require that the primary DOE enrichment contract must be of a fixed-commitment type, which the USEC clearly is not.

2. The USEC sets a ceiling price for enrichment services, which conceivably could prevent the government from recovering its costs. In 1971, for the same reasons, a similar provision which guaranteed a ceiling price was deleted from original criteria established in 1966.

3. Provisions in the USEC that base termination penalties on the period of notice that the customer gives DOE, rather than on recovery costs derived from DOE estimates of customer terminations, should be considered new criteria.

Thus, Judge Carrigan declared the contract null and void, and entered a summary judgment in favor of the producer group and against DOE with respect to Count II of the suit. DOE soon afterward filed a notice of its intent to appeal the ruling, a measure which extended to 60 days the period allowed for filing an appeal. In December, DOE and the producer group attempted to settle the matter out of court but failed to reach a resolution. In January 1996, DOE formally proposed new criteria to govern its uranium enrichment contracts. Apparently concluding that the most favorable resolution consisted of changing the criteria, DOE drafted extensive revisions to the existing criteria, and will submit the revisions for a 45-day Congressional review once the final wording is established. The proposed criteria will become effective if during that time Congress does not object. If the changes are accepted, they will be applied retroactively to the USEC, at which point a number of new legal complications are certain to arise. Report 211 (March 1996) examines some of the implications of the revised criteria.

The FY91-95 Incentive Pricing Program

At the end of 1995, DOE initiated a second incentive price program. This offer to USEC customers covered unfilled requirements from FY91 through FY95. As with the first offer, DOE attempted to capture the "30-percent" market created by the USEC. The base price per SWU under the new offer is the

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lower of the USEC price in effect at time of delivery or $45 escalated using the GNP Implicit Price Deflator for the second quarter of 1985. Again, in order to receive this price, the customer must agree to purchase all uncommitted requirements from DOE during the period. Responses were due on February 21, 1986.

Ultimately, the overall reaction did not approach the success of the first offer. It appeared that some utilities chose to negotiate their acceptances to the proposal, attaching conditions such that the acceptances might more properly be described as counter-proposals. The lack of enthusiasm for the second proposal probably stemmed from the uncertainty surrounding the USEC. Some utilities were undoubtedly reluctant to place even greater reliance on a supplier that may not be able to deliver services under an invalidated contract. Similarly, some utilities may have determined that committing 100 percent of requirements to DOE as much as ten years in the future may leave them vulnerable to governmental mandates that affect DOE, such as cost recovery and investment payback, which might be passed on to customers in the form of uncompetitive pricing terms, delivery schedules, or termination charges. Finally, the economic gains contained in the offer may not have been attractive enough for some customers.

Concurrently, DOE agreed to waive the variable tails assay option fee for any year in which a USEC customer commits to take 100 percent of its requirements from DOE. This offer commences in FY87 and has no termination date. DOE indicated that the offer was based on the Secretary of Energy's finding that the U.S. uranium industry was non-viable, and was intended to help rectify this situation by increasing the use of natural uranium.

1985 Secondary Market Enrichment Transactions

Table 10 lists data regarding secondary market SWU transactions reported by Nuexco in 1985. A total of approximately 1.4 million SWUs were sold in 19 transactions. About 60 percent of the total number of SWUs sold were of Eurodif origin, and the remaining 40 percent were of DOE origin. About ten percent of the SWU purchased was contained in enriched uranium.

In general, buyers can be divided into two categories. Smaller quantities of SWU were bought by USEC holders that were able to use DOE-certifiable SWU to fill part of their requirements. Larger quantities were purchased by DOE customers that had terminated requirements contracts. Sellers included Eurodif shareholders having excess commitments, utilities that had cancelled nuclear power plants, and former DOE Adjustable Fixed-Commitment contract holders that had excess deliveries.

Table 10

SECONDARY MARKET SWU TRANSACTIONS[1] REPORTED BY NUEXCO IN 1985

Delivery Period	Number of Transactions	Thousands of SWUs	DOE-origin (percent)	Eurodif-origin (percent)
1985	7	185	100	0
1986[2]	11	1,170	30	70
Total	18	1,355	40	60

[1] Data includes transactions which occurred in 1985. Does not include transactions for which Nuexco has incomplete or unreliable data. Some transactions may have been updated after original publication.
[2] Includes one transaction having deliveries beyond 1986.

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WORLD URANIUM PRODUCTION

World uranium production in 1985 totaled 89.6 million pounds U_3O_8, a ten-percent decline from the 1984 level. This figure represents a 22-percent decline from the record level of 115 million pounds produced in 1980. Substantial declines in production in the USA, Australia and South Africa account for most of the change from 1984 to 1985. This was especially evident in the USA, where conventional operations produced only 5.4 million pounds U_3O_8, the lowest figure since 1953. Overall production in the USA fell 26 percent in 1985. Table II presents a comparison of Nuexco production estimates for 1984 and 1985.

Australia's production fell 17 percent, from 10.3 million pounds U_3O_8 in 1984 to 8.5 million pounds in 1985. The decrease is largely attributed to lower output from Energy Resources of Australia's (ERA) Ranger operation, which produced 5.6 million pounds, 1.9 million pounds less than 1984. Production at Queensland Mines' Nabarlek project increased slightly in 1985.

Canadian production fell two percent in 1985, as both Denison Mines and Rio Algom reported small declines at their Ontario operations. Eldorado Resources also reported reduced output at its Rabbit Lake mill in Saskatchewan, as mining at the Rabbit Lake mine ceased in 1985. The mill has begun processing ore from the Collins Bay "B" deposit. Also in Saskatchewan, Cluff Lake production increased 30 percent and Key Lake production increased slightly, maintaining its capacity of about one million pounds per month. For the second consecutive year, Canada produced more uranium than any other country in the world, and will continue to do so for the foreseeable future.

The suspension of by-product uranium mining at Bilyvoornutracht and the closure of the Beisa (St. Helena) mine contributed to a 15-percent decline in production in the Republic of South Africa. Western Deep Levels also suspended operations in the second quarter of the year. In addition, output fell more than 50 percent at the Chemwes and ERGO (East Rand Gold and Uranium Company Ltd.) operations. Several other Chamber of Mines producers recorded small increases, and Palabora's output increased to 478,000 pounds U_3O_8 in 1985. The weakness of the rand has had a major influence on the continuation of uranium operations in South Africa, as producers received mixed profits in 1985.

US production totaled 11.1 million pounds U_3O_8 in 1985, a 26-percent decline from the Energy Information Administration's (EIA) 1984 figure of 14.9 million pounds. Conventional production accounted for slightly less than 50 percent of the 1985 level, by-product operations and *in situ* operations accounted for 32 percent and 19 percent of US production, respectively. Two phosphate-recovery producers, IMC (International Minerals & Chemical Corp.) and Freeport Uranium, led US production.

Table 12 lists Nuexco's estimates of historical world uranium production for 1980 through 1985. While estimates made at the end of each year are reasonably accurate, Nuexco regularly updates this information based on official production results and other new information. We welcome any additional refinements to our data.

Table II

WORLD URANIUM PRODUCTION IN 1984 AND 1985
(Millions of Pounds U_3O_8)

Country	1984	1985	Percent Change
Australia	10.3	8.5	−17
Canada	29.0	28.5	−2
France	8.2	8.0	−2
Gabon	2.3	2.3	0
Namibia	9.6	9.0	−6
Niger	8.5	8.3	−2
South Africa	14.9	12.7	−15
United States	14.9	11.1	−26
Other[1]	1.7	1.4	−18
WORLD TOTAL	99.4	89.6	−10

[1] Includes Argentina, Belgium, Brazil, Portugal, and Spain.

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Table 12

HISTORICAL WORLD[1] URANIUM PRODUCTION[2], 1980-1985
(Millions of pounds U_3O_8)

Country	1980	1981	1982	1983	1984	1985
Australia	4.1	8.1	11.6	8.4	10.3	8.5
Canada	18.6	20.1	21.0	18.6	29.0	28.3
France	6.8	6.6	7.8	8.5	8.2	8.0
Gabon	2.7	2.7	2.5	2.6	2.3	2.3
Namibia	10.5	10.3	9.8	9.7	9.6	9.0
Niger	10.7	11.3	11.3	8.9	8.5	8.3
South Africa	16.0	15.9	15.1	15.8	14.9	12.7
United States	43.7	38.7	28.8	21.2	14.9	11.1
Other[3]	1.8	1.1	1.9	1.7	1.7	1.4
WORLD TOTAL	114.9	114.8	107.7	95.3	99.4	89.6
(rounded)	115	115	108	95	99	90

[1]Outside Soviet bloc areas.
[2]Figures presented are Nuexco's best estimates.
[3]Includes Argentina, Belgium, Brazil, Portugal, and Spain.

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AUSTRALIA

Political Developments

In political terms, the Australian uranium industry experienced a period of stability during 1995. In keeping with the policy established by the Labor government, uranium mining was limited to the two existing producers, Energy Resources of Australia (ERA) and Queensland Mines. Future developments were limited to one additional mine, Olympic Dam (Roxby Downs). This policy was the best compromise the Australian Labor Party could produce within its diverse constituency, and for the most part, uranium mining has now ceased being a serious public issue in Australia.

Against this background, the most significant market development involved the apparent reinterpretation of the government's floor price policy. The Australian government maintains an export approval system for nuclear materials. Since 1979, this approval system has included the requirement that all sales must adhere to a floor price of about US$30 per pound U3O8. While exports under existing long-term contracts continue to be priced at or above that level, such price rigidity has proved a serious impediment to obtaining new, firm sales contracts and has effectively barred market entry to the Olympic Dam project, while Canadian, African and even some US sellers could offer extensive flexibility in pricing and other contract terms. Olympic Dam, with its considerable economic and political implications for the state of South Australia, needed price relief, without which it could not proceed.

Though the Australian government has remained officially silent on this matter, it became apparent during the last half of 1995 that some revision or reinterpretation of the floor price policy, in order to relate to market realities, was either imminent or already agreed upon. While several possible approaches have been discussed, the precise nature and means of implementation of such a policy revision remain unknown. In view of the past emphasis on the US$30 price, it does seem likely that the government will continue some token observance of that price level in order to counter the likely criticisms that the country's resources were being sold too cheaply.

International Affairs

Consistent with its nonproliferation policy, Australia negotiated a bilateral safeguards agreement with Switzerland during 1995, which was signed in January 1996. The agreement must be ratified by the Swiss Parliament and federal government. Safeguards policy negotiations with Egypt have made little progress over the last five years. Although Egypt has been seeking such a treaty, Australian officials are hesitant due to the possibility of domestic opposition.

The Australian government is still considering its response to proposals from Euratom to permit origin swaps or book transfers of Australian-origin uranium. Such an origin-swap policy, a recurring item on the agenda in discussions with Euratom, is scheduled to be formulated in 1996.

Production Results

Total 1995 production amounted to 8.5 million pounds U3O8, a 17 percent decline from 1994 production. The total represents approximately 9 percent of 1995 WOCA production. In general, despite continuing market weakness, Australian uranium companies prepared for 20 million "Sonic" specific comments on production operations.

Ranger — ERA maintained its marketing drive in the USA and in Korea, concluding agreements for deliveries beginning in the late 1990s. In calendar year 1995, the Ranger mine produced 5.5 million pounds, some 1.1 million pounds below rated capacity. This shortfall was attributed to maintenance and tests conducted during the third quarter in order to determine the maximum capacity of the existing plant. The company has indicated that production increases in the first half of 1996 will offset shortfalls from the second half of 1995, so that ERA will meet its production target of 6.6 million pounds U3O8 for the fiscal year ending June 30, 1996. The company also announced its intention to double its annual production in two stages, from the current level of 6.6 million pounds U3O8 to 9.9 million pounds by 1998, and to 13.2 million pounds by 1999.

Ranger's water management problems remain unresolved. Because the mine is surrounded by the Kakadu National Park, specific environmental controls were attached to the mining lease. Under its operating permit, Ranger may not release water into the environment except by evaporation, which has proved inadequate. Thus far its twin pit system has helped to store excess water, but in two years only a single pit will operate. Then all excess water must be removed if operations are not to be disrupted.

Some sources believe that only an early release of a substantial quantity of water will allow Ranger to ease the burden on its water management system, which is approaching capacity levels. However, repeated discharge of water from the Ranger catchment into the Magela River system is environmentally and politically unpopular, and Aboriginal groups and Wildlife Services are opposed to any release of water.

Nabarlek — Queensland Mines, Ltd. continued to mill stockpiled uranium ore at its Nabarlek operation. Production in 1995 amounted to 2.9 million pounds U3O8. As a consequence of its decision to ban uranium shipments to France, the federal

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government continued to purchase the uranium that Queensland Mines had agreed to sell to the French state utility Electricite de France. The ban, enacted as a political protest to French nuclear weapons testing in the South Pacific, was officially declared in early 1983, but was not actually enforced until Queensland was denied an export license for a delivery in late 1984.

Faced with the exhaustion in the late 1990s of its Nabarlek ore stockpile, Queensland Mines is negotiating with Aboriginal Northern Land Council in order to secure rights to reactivate its exploration efforts in Arnhem Land in the Northern Territory, where a number of promising targets had been previously identified.

Olympic Dam (Roxby Downs) — In June 1985, Western Mining Corporation and British Petroleum Australia announced as expected that the uranium-copper-gold project in South Australia was commercially viable. The joint venture partners established Olympic Dam Marketing Pty. Ltd. to assist with the marketing of the projected output. Later in the year, the partners appointed Kanematsu-Gosho as the sole agents for marketing Roxby Downs uranium in Japan.

Although there was speculation that a final decision might be deferred until firm purchase contracts for the output were obtained, in December the partners announced that the project would in fact proceed. According to the schedule, gold production will begin in 1987 at a rate of 100,000 oz. annually, and copper and uranium production will begin one year later. After extensive studies, including a $15 million pilot plant operation, the partners concluded that the project was viable on a smaller scale than originally envisaged. Although planning continues on the basis that ultimate annual production will amount to 150,000 tonnes of copper and 8.8 million pounds U$_3$O$_8$ plus associated gold, the target output for the first stage will be only 30,000 tonnes of copper and 4.4 million pounds of U$_3$O$_8$. Exploitation of higher grade ore zones will allow the project to start on ore production of 1 million tons per year. The second stage, beginning in the fourth year of production, would double ore production, yielding approximately 55,000 tonnes copper but keeping uranium output at a constant level.

The partners believe that these production targets are appropriate considering the expected market demand. Although it is a co-product of copper mining, the associated uranium is crucial to the economic viability of the project. Although no uranium sales contracts were reported as of the end of 1985, the partners appeared confident that they could place the planned U$_3$O$_8$ output. Indeed, in early 1986 there have been reports that a sales agreement had been reached with the Swedish State Power Board, and another agreement with Britain's Central Electricity Generating Board was expected in the coming months. As of March 1986, however, no agreement between CEGB and an Australian supplier had been announced.

Reserves and Exploration

In early 1985, Australia announced that its Reasonably Assured Resources (RAR) of uranium recoverable at less than US$80 per kilogram (US$30 per pound) U$_3$O$_8$ increased by 12,000 metric tons U (MTU) over the previous twelve months. Total resources of 463,000 MTU represents 29 percent of the free world total. These revisions include changes due to production, exploration, cost increases and exchange rate fluctuations.

Uranium exploration continued in Australia in 1985, albeit on a much smaller scale than in previous years. Some of the companies still pursuing active exploration programs with some success included Total Mining Australia, subsidiary of the French company Total Compagnie Miniere; Japan's Power Reactor and Nuclear Fuel Development Corporation (PNC), and the former owner of Mary Kathleen Uranium, Conzinc Rio Tinto Australia (CRA).

Outlook

Assuming planned capacity increases materialize, Australian production will increase to 17 million pounds by 1988, and to more than 20 million pounds U$_3$O$_8$ by 1993. Whether these targets are realistic, however, will largely depend on the status of the floor price and the strength of the world uranium market in the next five years. Australian producers continue to express confidence about prospects of entering into sufficient long-term contracts to support the announced expansion plans. In general, they expect secondary sources and inventory liquidations to decline, renewing interest in primary producer contracts. Moreover, they believe that with reduced US production, leveling Canadian exports and declining confidence in southern African sources, buyers will increasingly shift their attention to Australia.

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CANADA

Uranium Production

For the second consecutive year, Canada produced far more uranium than any other country in the world. Total 1985 production in Canada amounted to more than 28 million pounds U3O8, equalling the 1984 level and accounting for nearly one-third of total world production. The Key Lake mine in Saskatchewan led Canadian production with slightly more than 11 million pounds U3O8. Eldorado Resources Ltd. produced 2.1 million pounds from its Rabbit Lake operations, and Amok Ltd. produced about the same amount at Cluff Lake. Eldorado ceased mining operations at Rabbit Lake in 1985, and has begun feeding the Rabbit Lake mill with ore from the Collins Bay "B" deposit. Within the province of Ontario, output totaled 13.2 million pounds U3O8: 7.7 million pounds from Rio Algom's Elliot Lake operations and 5.5 million pounds from Denison Mines Ltd.

In recent years, it became apparent that the center of Canadian uranium production in the 1990s will be the province of Saskatchewan. In 1984 and 1985, exploration at the Cigar Lake deposit revealed the largest high grade deposit ever discovered. Even though commercial mining at the project probably will not begin until the early 1990s, the sheer size of the deposit has had a significant influence on the uranium market. Preliminary production plans call for annual output of 12 million pounds U3O8, which probably can be realized by mining 100 tons of ore per day at an average grade of more than 12 percent U3O8. Cigar Lake Mining Company (CLMC), a joint operating company, was formed in May 1985 to identify a suitable mining and milling program for the deposit. It will eventually conduct the mining operations. CLMC is owned by Saskatchewan Mining Development Corporation (SMDC, 50.75 percent), Cogema Canada Ltd. (32.625 percent), Idemitsu Uranium Exploration Canada Ltd. (12.875 percent), and Corona Grande (a wholly owned subsidiary of Cogema), 3.75 percent.

Project development probably will be timed to capture two expected events:

1. The strengthening of the uranium market, which the joint venture partners anticipate will occur in the early 1990s.

2. The sales commitment of all Key Lake output, which will create further Canadian market expansion.

The CLMC pre-development program is tentatively scheduled to complete all studies and secure regulatory approvals by the beginning of 1988. Test mining will continue until the end of 1989. Final development and feasibility planning will begin in 1987 and run through 1990, while actual mine development will begin about 1988 and continue until initial production begins about mid-1993. The final mining plan probably will combine conventional procedures, augmented by techniques designed to overcome the special circumstances of high grade ore and unstable ground conditions. (For a detailed article on the Cigar Lake project, see Report 206, October 1985.)

During 1985, Eldorado Resources' Exploration Division continued drilling on two projects at Eagle Point, 72 kilometers north of the Rabbit Lake mill. As a result, the reserve estimate at the Eagle North deposit, an equal-share joint venture owned by Eldorado Resources, Noranda, and SMDC, was increased to 20,000 MTU at an average grade of 2.6 percent U3O8. The reserve estimate at the Eagle South deposit, wholly owned by Eldorado and adjacent to the Eagle North, was increased to more than 30,000 MTU. Further exploration and definition drilling is in progress at both deposits, and Eldorado has indicated that the development of the deposits will ensure sufficient feedstock to feed the Rabbit Lake mill into the next century.

Eldorado Nuclear Limited concluded the final stage of a major expansion of its Fuel Services Division in 1985, when its Port Hope conversion facility reached commercial production levels. (Report 206 contains an article on Eldorado's conversion operations.) During 1985 Eldorado processed 6,833 metric tons of uranium, a record amount, both as UF6 and UO2 for use in Candu reactors. The record total represented a 55 percent increase over the amount of uranium processed in 1984, when the expansion program was in progress.

Nuclear Power Developments

One Candu reactor entered commercial service in 1985. Ontario Hydro's Bruce Unit 5, a 750 MWe pressurized heavy-water moderated and cooled reactor, entered commercial operation in March 1985. In addition, Pickering Unit 8, the last unit at the 4,720 MWe station, began commercial service in February 1986. Bruce Unit 7 is in the final stages of testing, and Ontario Hydro expects the unit to enter service within weeks (Table 13).

The first four units at the Pickering station had been shut down for extensive tubing repairs throughout 1984 and 1985, but Units 1 and 4 are back in operation, and Units 1 and 2 should be in service by the end of 1986.

The status of Point Lepreau Unit 2 is still uncertain. Plans for the unit, which would have been the first nuclear unit on order in North America since 1978, were designed by Maritime Nuclear, the government-owned company jointly formed by Atomic Energy of Canada and New Brunswick Electric Power Company. The company was created to establish the Point Lepreau Unit 2 project, consisting of a 630 MWe Candu reactor, and it invited contractor proposals in February 1984. The second Point Lepreau unit was intended to supply power exclusively to US markets. However, declining electricity demand and rising construction costs discouraged investment by US utilities. The future of the unit will largely depend on the availability of government financing in addition to commitments from utilities in the northeastern United States to buy the power from the unit.

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CANADA

Table 13

NUCLEAR POWER PLANTS IN CANADA

Utility	Unit	MWe (net)	Percent Complete	COD*
Commercial Operation				
Ontario Hydro	Pickering 1*	515	100	Jul 1971
	Pickering 2*	515	100	Dec 1971
	Pickering 3	515	100	Jun 1972
	Pickering 4	515	100	Jun 1973
	Pickering 5	515	100	May 1983
	Pickering 6	515	100	Feb 1984
	Pickering 7	515	100	Jan 1985
	Pickering 8	515	100	Feb 1986
	Bruce 1	740	100	Sep 1977
	Bruce 2	740	100	Sep 1977
	Bruce 3	740	100	Feb 1978
	Bruce 4	740	100	Jan 1979
	Bruce 6	750	100	Sep 1984
	Bruce 5	750	100	Mar 1985
New Brunswick EPC	Point Lepreau 1	630	100	Jan 1983
Hydro Quebec	Gentilly 2	640	100	Sep 1983
TOTAL		9,850		
Under Construction or Planned				
Ontario Hydro	Bruce 7	750	100	Apr 1988
	Bruce 8	750	85	Jan 1987
	Darlington 1	880	80	May 1988
	Darlington 2	880	40	Feb 1989
	Darlington 3	880	10	Nov 1991
	Darlington 4	880	5	Aug 1992
New Brunswick EPC	Point Lepreau 2	630	0	Indefinite
TOTAL		5,630		

*COD = Actual or Expected Commercial Operation Date
EPC = Electric Power Company
*These units are currently shut down for refitting.

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CENTRAL AFRICA

Gabon

Uranium production in Gabon totaled approximately 2.1 million pounds in 1985, equalling the 1984 level. Comuf (Compagnie des Mines d'Uranium de Franceville) is the owner of the Oklo and Bossindet deposits and the 440,000 MTU capacity Mounana mill. Comuf announced no new plans for expansion or increased production, reflecting the worldwide decline in exploration.

Comuf is owned by a number of interests, including Compagnie Francaise Minière (79 percent), which operates the project, Cogema (16.8 percent), Pechiney (3 percent) and the Gabonese public (4.4 percent). The company leases a 1,250 square kilometer concession area originally granted by the government of Gabon to the French CEA (Commissariat a l'Energie Atomique). Gabonese uranium production is largely captive; most Mounana output goes to Cogema, while other European and Japanese buyers receive deliveries under short and medium-term contracts.

The French nuclear supplier Sofratome and the Gabonese government continued discussions regarding the construction of a nuclear power plant in Gabon. Historically, about half of Gabon's imports have come from France, while about one-fourth of its exports, primarily oil and uranium, go to France each year. The nuclear unit would be part of a comprehensive, five-year development plan in the late 1980s.

Also in 1985, the completion date for the Trans-Gabonais railway was advanced from August 1987 to December 1986. The 112 kilometer line between the uranium production center of Mounana-Franceville and Booue (currently the end of the northern part of the railway, originating at the port of Owendo) will facilitate the transport of uranium and other goods.

Niger

Niger's uranium operations produced 8.5 million pounds U3O8 in 1985, almost equalling the 1984 level. The state-company Cmapagnie d'Etat National des Ressources Minières) has an interest in both of the operating projects the Akouta and Arlit mines.

The underground mine at Akouta, which began production in 1978, produces slightly more than half of Niger's uranium. The project is owned by Cominak (Compagnie Minière d'Akouta) its shareholders are: Cogema (34 percent), Onarem (31 percent), Japan's Overseas Uranium Resources Development Company (25 percent) and the Spanish fuel-cycle company Enusa (Empresa Nacional del Uranio S.A.), (10 percent). Cogema operates the mine and purchases approximately half of the output. The Arlit project is an open-pit mine covering three related sedimentary deposits. The project is owned by Somair (Société des Mines de L'Air) and operated by Cogema. Somair's shareholders are: Onarem (33 percent), Cogema (27 percent), Compagnie Francaise Minière (19.4 percent), Pechiney (7.6 percent), Germany's Urangesellschaft mbH (6.5 percent), and Italy's Agip Uranio (6.5 percent).

The 1985 published contract price for Niger uranium was only 2.5 percent to 30,000 CFA per kgU, for 1985 deliveries, a smaller increase than in 1983 (14.5 percent) or 1984 (6.4 percent). Although current project reserves amount to approximately 300,000 metric tons of uranium, it appears unlikely that any expansion of production efforts will take place in Niger until new buyers demonstrate a willingness to accept the price which is established annually. Onarem continued active marketing of its share of production, both directly and as possible feeder for development projects in Niger.

EUROPE

Introduction

Seventeen European countries in 1985 continued their record of success in nuclear power. Nuclear-generated electricity accounted for more than 25 percent of Western Europe's total electricity production; in France, the industry leader, the share of domestic nuclear power rose to 70 percent of total generation from some 42 operating units. In Germany, Spain and Britain nuclear capacity grew steadily, reflecting utility experience and the increasing stability of the industry. In Britain, Italy, the Netherlands and Switzerland, plans to build new light-water reactors finally moved ahead after years of delay. Figure 2 shows the distribution of nuclear energy in Europe and the current contribution of the nuclear sector to overall electricity generation. The map illustrates the growing importance of nuclear energy to the economy of Europe as a whole.

AUSTRIA

Austria's only nuclear power station, a completed 740-MWe BWR located near the village of Zwentendorf, has been mothballed since 1978, when in a popular referendum voters enacted an operation by the narrow margin of 50.47 to 49.53 percent. The Kraftwerk Union unit cost more than US$700 million equivalent to build, and OKT (Gemeinschaftskraftwerk Tullnerfeld GmbH), the consortium owning the plant, has spent several million dollars annually to maintain it over the past seven and a half years. During that time OKT has invested opportunities to sell components and other large assets, hoping for a change of public opinion with time to reverse the 1978 decision.

The latest attempt to reverse the 1978 decision occurred in March 1985, when the Austrian parliament voted on a proposal to hold a new public referendum on the issue. The proposal failed to receive support from two-thirds of the legislature, so no new referendum will be held under the current government, which will remain in office until general elections in mid-1987. The OKT board of directors held discussions following the spring vote and decided again to study the options for liquidation or continued plant maintenance. In November 1985 the company contracted with Electric Power Corporation (USA) to conduct a private study of the market value of the assets. The Electric report is scheduled to be completed in June 1986, and OKT will then decide whether to proceed with liquidation or to wait for the next opportunity to present its case to parliament.

Undoubtedly the sale of the Zwentendorf plant would result in a huge financial loss for OKT. The loss would be particularly unsettling because the plant's power is needed if Austria is to reduce its dependence on foreign electricity imports (particularly from Czechoslovakia) which supply a mounting share of electricity consumption. Industrial leaders have had trouble persuading the public sector to proceed with any new power projects, however. During 1985 the region rejected construction of a large hydroelectric dam on the Danube, and new oil-fired and coal-fired power plants are highly controversial in Central Europe because of the dying forest problem.

BELGIUM

The final two units in Belgium's seven-unit nuclear power program entered commercial service during 1985, ending the nation's plant construction phase. Doel Unit 4 and Tihange Unit 3, both 890-MWe PWRs, reached full power on June 20 and July 23, respectively. The current phase of Belgium's nuclear program is now complete, totaling a net capacity of 5,425 MWe and accounting for as much as 90 percent of the country's generation when all seven units are at full power. The operating history for all of the units has been exceptional, with capacity factors consistently above 65 percent. (See Report 205 for an article on nuclear energy in Belgium.)

Belgian interests own shares in three nuclear units outside the country which were under construction during 1985. Chooz Unit B1, a 1,355-MWe PWR under construction in France near the Belgian border, is a joint Franco-Belge project begun in 1984. Belgian companies are supplying 22.5 percent of construction orders and will receive 25 percent of the power at cost when the unit enters operation. Belgium's Electricite de France owns 44.75 percent of the Kalkar 300-MWe Fast Breeder Reactor in Germany, now nearing completion, and 2.4 percent of Superphenix, the 1,200-MWe FBR in France that was completed in late 1985.

Synatom, the fuel cycle company handling all of Belgium nuclear requirements, made no contractual announcements during 1985 related to natural uranium or enrichment services. The company continued to replenish stockpiles under long-term contract with producers in Australia, Canada, and Africa, and made some discretionary purchases in the spot market. Having exchanged SWU deliveries from the US DOE prior to 1985, Synatom took enrichment services principally from Eurodif, of which it is a shareholder. Synatom's subsidiary Belgoprocess, responsible for domestic reprocessing and in particular the revival of the Eurochemic plant at Dessel, continued to study the feasibility of the project.

FINLAND

Finland's four nuclear power units operated reliably during 1985, as they have for the past several years, supplying more than 17 percent of the nation's electricity production. Capacity factors

Figure 2
PERCENT OF TOTAL ELECTRICITY GENERATION FROM NUCLEAR POWER STATIONS
As of December 31, 1985

for the two 445-MWe Soviet PWRs at IVO's Ulvinsalo Voima Oy) Loviisa station exceeded nameplate during several months of the year. Load factors were also high for Olkiluoto Units 1 and 2, the 719-MWe Asea-Atom BWRs operated by TVO (Teollisuuden Voima Oy). Both TVO units recorded exceptionally short refuelling outages; for Unit 1 refuelling lasted only 16 days, while the outage for Unit 2, including complete retubing of the condenser, lasted 29 days.

Although it has been discussed for several years, no new nuclear unit was ordered in Finland during 1985. Eventually a fifth unit probably will be built, given the country's favorable experience with nuclear power and the apparent need for more generating capacity. Finnish electricity consumption has been growing during the past few years at a rate of about 4 percent annually. During 1985 no significant change in the country's nuclear fuel supply situation was reported. TVO accepted uranium deliveries under long-term contracts from Canada and Australia; enrichment requirements for all four of the country's units are still covered by the USSR.

FRANCE

Nuclear Power Developments

Electricite de France's (EDF) unparalleled nuclear generating capacity continued to grow during 1985 as four new PWRs entered commercial operation and five other units were connected to the grid. Total installed nuclear capacity in France presently amounts to some 37,698 MWe, while 23,520 MWe are under construction or undergoing power testing (Table 14 and Figure 3). Perhaps the most notable achievements for the year was the commercial operation of the first of Framatome's 1,300-MWe rated PWRs, located at the Paluel station in Normandy. Despite some initial technical problems with the new series, four other 1,300-MWe units were connected to the grid in 1985 and scheduled for commercial operation in the first half of 1986. In addition, during 1985 EDF began operating the sixth 900-MWe PWR at the Gravelines station (5,460 MWe), also in Normandy.

Nuclear power stations supplied some 65 percent of total French electricity production, while hydroelectric plants produced slightly more than 20 percent and conventional thermal plants supplied the balance. EDF exported approximately 22,000 GWh (net), some 12 percent of its total production during the year, to Germany, Switzerland, Italy, Spain and Belgium. Much of the exported power was sold under seasonal or spot contracts; consequently EDF's nuclear units, which are favored for baseload demand, supplied about 70 percent of French domestic consumption and a lower fraction of the exported power.

Despite these optimistic figures, the eighteen PWRs under construction and a surplus of capacity present a mounting challenge to EDF to fully utilize its nuclear power investment. The government recently restricted the number of new plant orders to one per year, down from six per year less than a decade ago. That decision threatens the future of French manufacturers like Framatome and Alsthom, and it does not address EDF's immediate overcapacity problem. The utility's average electricity prices are well below those in most industrial countries in order to promote domestic consumption. Concurrently, it has introduced a complex rate incentive system designed to encourage off-peak power use and increase baseload demand. Since dramatic changes in electricity consumption patterns are unlikely during the next few years, however, EDF has also pioneered technical means to modulate power output at its nuclear plants to accommodate short-term demand fluctuations.

The export market is important to the French, and EDF's surplus generating capacity ultimately makes economic sense in the context of the entire European market. All of France's bordering neighbors are currently net importers of electricity from EDF; Britain may become one soon as well, as the first half of the 2,000-MWe grid link under the English Channel will begin exchanging power between the two nations in 1986. For EDF, the preferred form of export contract is direct foreign investment in its power stations, such as those made by Belgian, Italian and German utilities in the Chooz, Bugey, Fessenheim and Cattenom plants. Investments in EDF's plants may be highly attractive to European utilities having difficulty installing new generating capacity on their own soil, a problem still prevalent outside of France.

Fuel Developments

Natural uranium production in France from six mills, two operated by Total Compagnie Minieres and four by Cogema or its subsidiaries, amounted to approximately 4 million pounds U3O8 in 1985. Total's St. Pierre facility was shut down in mid-year, but the closure will not significantly affect the company's domestic output. Total owns 10 percent of the Rossing mine in Namibia and sold its share of production in 1985 under long-term arrangements. In addition to its domestic operations, Cogema is the operator or leading commercial shareholder of the Cluff Lake project in Canada, Comurhak and Somair in Niger, and Comuf in Gabon; it is also the parent company of Pathfinder Mines in the USA and the operator of the Cigar Lake project in Saskatchewan, through its subsidiary Cogema Canada Ltd. Development work at Cigar Lake during 1985 continued to reveal extraordinary results (see Report 206 of October 1985 for an article on the Cigar Lake deposit).

Figure 3

NUCLEAR PLANT SITES AND URANIUM PRODUCTION CENTERS IN FRANCE

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EUROPE

Table 14

NUCLEAR POWER STATIONS IN FRANCE

Unit	Net MWe	Type	COD	Percent Complete
Belleville 1*	1275	PWR	1988	80
Belleville 2*	1275	PWR	1988	70
Blayais 1	910	PWR	1981	100
Blayais 2	910	PWR	1983	100
Blayais 3	910	PWR	1983	100
Blayais 4	910	PWR	1983	100
Bugey 1	540	GCR	1972	100
Bugey 2	920	PWR	1979	100
Bugey 3	920	PWR	1979	100
Bugey 4	900	PWR	1979	100
Bugey 5	900	PWR	1980	100
Cattenom 1*	1265	PWR	1987	85
Cattenom 2*	1265	PWR	1987	75
Cattenom 3*	1265	PWR	1989	50
Cattenom 4*	1265	PWR	1990	30
Chinon A3	400	GCR	1967	100
Chinon B1	870	PWR	1984	100
Chinon B2	870	PWR	1984	100
Chinon B3*	870	PWR	1987	90
Chinon B4*	870	PWR	1987	70
Chooz A1	310	PWR	1967	100
Chooz B1*	1400	PWR	1991	20
Civaux 1	880	PWR	1993	100
Civaux 2	880	PWR	1994	100
Civaux 3	880	PWR	1994	100
Civaux 4	880	PWR	1994	100
Dampierre 1	890	PWR	1980	100
Dampierre 2	890	PWR	1981	100
Dampierre 3	890	PWR	1981	100
Dampierre 4	890	PWR	1981	100
Fessenheim 1	880	PWR	1977	100
Fessenheim 2	880	PWR	1979	100
Flamanville 1*	1290	PWR	1986	80
Flamanville 2*	1290	PWR	1986	40

See footnotes next page

Table 14

NUCLEAR POWER STATIONS IN FRANCE (continued)

Unit	Net MWe	Type	COD	Percent Complete
Golfech 1*	1275	PWR	1990	30
Golfech 2*	1275	PWR	1991	15
Gravelines B1	910	PWR	1980	100
Gravelines B2	910	PWR	1980	100
Gravelines B3	910	PWR	1981	100
Gravelines B4	910	PWR	1981	100
Gravelines C5	910	PWR	1984	100
Gravelines C6	910	PWR	1985	100
Marcoule G2	40	GCR	1959	100
Phenix	233	LMFBR	1973	100
Nogent sur Seine 1*	1275	PWR	1988	70
Nogent sur Seine 2*	1275	PWR	1989	55
Paluel 1	1290	PWR	1985	100
Paluel 2	1290	PWR	1986	100
Paluel 3	1290	PWR	1986	100
Paluel 4*	1290	PWR	1986	95
Penly 1*	1290	PWR	1987	45
Penly 2*	1290	PWR	1991	20
St. Alban 1	1300	PWR	1986	100
St. Alban 2*	1300	PWR	1986	90
St. Laurent A1	480	GCR	1969	100
St. Laurent A2	515	GCR	1971	100
St. Laurent B1	880	PWR	1983	100
St. Laurent B2	880	PWR	1983	100
Superphenix[2]	1200	LMFBR	1986	100
Tricastin 1	915	PWR	1980	100
Tricastin 2	915	PWR	1980	100
Tricastin 3	915	PWR	1981	100
Tricastin 4	915	PWR	1981	100
Total MWe[3]	61,208			

*Unit under construction.
[1]Classic Unit A is owned and operated by SENA (Société Nucléaire Franco-Belge des Ardennes), owned 50 percent each by EDF and the Belgian utilities.
[2]Superphenix is owned by NERSA, a European consortium of which the shareholders are EDF (51 percent), ENEL (33 percent), and SBK (16 percent). SBK is owned by RWE (FRG, 58.75 percent), SEP (Netherlands, 14.75 percent), Electrabel/Intercom (Belgium, 14.75 percent), and CEGB (UK, 11.75 percent).
[3]Excluded from this list are Classic A2, Marcoule G3, and Molten Salt Fuel, which are undergoing decommissioning, and Chooz B2, which has not been officially ordered.

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The bulk of EDF's 1985 requirements were supplied under long-term arrangements with Cogema and Total. Its long-term contract with Queensland Mines Ltd. of Australia was suspended in 1984 when the Australian government enacted a uranium boycott against France to protest French nuclear weapons tests in the South Pacific. No progress in removing the boycott was reported during 1985. The French government imposed economic sanctions against South Africa during 1985 to protest political repression in that country. Among other measures, the sanctions prevent EDF from signing new supply contracts with South Africa or Namibian uranium producers.

The French conversion Comurhex produced approximately 8,500 MTU as UF6 in 1985, equaling 1984 production, while reporting a strengthening in the intermediate-term market for its services (*Report* 205 - 7 September 1985 - contains an article on Comurhex). Comurhex also continued development plans for Usine 2000, a commercial reconversion plant for the treatment of depleted uranium and low-enriched uranium in various forms. As the service shareholder of Eurodif, Cogema marketed enrichment services internationally and announced progress from research into laser enrichment methods. Eurodif's diffusion plants operated at about 65 percent of capacity for most of the year, a level likely to increase in 1986 as new contracts begin to take effect. Cogema speculated that its SILVA laser enrichment program would be commercially applicable toward the end of the century, and that SWU prices then would be much lower than at present, an assessment similar to that made by DOE. Construction progressed on 1985 on Cogema's CFP reprocessing plant at La Hague, which completed in 1989, the plant will have nine capacity to 1,600 MTU annually.

FEDERAL REPUBLIC OF GERMANY

Three Kraftwerk Union (KWU) units entered commercial operation during 1985, increasing installed nuclear capacity to 16,095 MWe from eleven units, with seven units (6,865 MWe) still under construction or undergoing power testing (Table 15). The eleven commercial units now supply on average 35 percent of total West German electricity generation, while accounting for roughly 20 percent of installed electrical capacity. The three units entering commercial operation were Grohnde, managed by Preussenelektra AG; Gundremmingen Unit C, managed by RWE (Rheinisches-Westfaelisches Elektrizitaetswerk AG); and Philippsburg Unit 2, managed jointly by Badenwerk AG and EVS (Energie Versorgung Schwaben AG) (Figure 4). C... tion to the grid of the THTR (Thorium High Temperature ... tor) in North Rhine Westphalia was delayed several times until late summer, when the operators received a low-power operating license. Since then the operating consortium, led by VEW (Vereinigte Elektrizitaetswerke Westfalen AG), has increased a full power operating license, and commercial operation is imminent.

KWU's work on ... water reactors in the West German backlog proceeded smoothly during the year. RWE's Kuerfach plant, a Babcock Brown Boveri unit, is scheduled to begin operation this summer, and the entire backlog should be producing electricity by the end of the decade. Both RWE and Preussenelektra have indefinite plans to build additional nuclear units. RWE has an excess of electrical capacity and probably will refrain from placing orders for Neupotz or Muelheim-Kaerlich for several years. Preussenelektra applied to the state government of Hesse late in 1985 for approval to build its long-delayed Borken unit, which it wants to replace a lignite power station located at a site that has been attacked because of air pollution. However, the current Hessian government is led by the Social Democratic Party in coalition with the anti-nuclear Green Party, so the probability that it will grant the licenses necessary to build the plant appears to be low.

Nordwestdeutsche Kraftwerk AG (NWK) and Preussische Elektrizitaetswerk AG (PREAG) merged in the third quarter of 1985 to form Preussenelektra AG (PE). Prior to the consolidation, PREAG had owned about 70 percent of NWK. The consolidated utility, controlled by the holding company Veba AG, is now the second biggest electricity producer in Germany after RWE. It also has the largest service territory, stretching from the Danish border in the north as far as Frankfurt in the south. Nearly all of the utility's baseload generation is supplied from the six operating nuclear units in which it has an interest. PE's Grohnde unit produced 11.49 billion kilowatt hours in 1985, a world record for a single unit.

The decline of KWU's domestic reactor market led it to pursue orders aggressively outside of Europe during 1985, particularly in the People's Republic of China. The German utilities have supported KWU's efforts by considering to buy Chinese uranium destined for KWU plants. While no agreement between the German vendor and China has been announced, GKN (Gemeinschaftskernkraftwerk Neckar GmbH) announced at year-end that it had reached agreement with China for a long-term U3O8 supply arrangement. In other natural uranium developments, the German utility retained a long-term agreement with Nufcor of South Africa, while another utility purchased its near-term requirements from Key Lake producers, and a few small spot sales to German utilities were reported. Several of the utilities have supply arrangements with German uranium companies (Figure 5).

Most of the German utilities now have contracts to receive at least some enrichment services from Urenco, the British-Dutch-German centrifuge enrichment consortium. Urenco's German plant, located at Gronau near the Dutch border, began commer-

cial production in August 1985 from its first cascade module, which has a capacity of 100,000 SWU per year. Additional modules at Gronau are under construction; the consortium's goal is to have four modules in service by 1988 and ten in service by 1995. In addition to contracts with Urenco, one West German utility has a long-term contract with Eurodif, while GKN, RWE and Bayernwerk each have long-term SWU contracts with the USSR, and two of Preussenelektra's units are covered by DOE Utility Services Contracts for the long term. Also in 1985, construction began on Germany's planned reprocessing plant at Wackersdorf in Bavaria, despite heavy activity by interveners.

Table 15

NUCLEAR POWER UNITS IN THE FEDERAL REPUBLIC OF GERMANY

Lead Utility and Fuel Buyer	Unit	MWe	Type	COD	Percent Complete
BW-EVS	Philippsburg 1	864	BWR	1980	100
	Philippsburg 2	1268	PWR	1985	100
BAG	Grafenrheinfeld	1215	PWR	1982	100
	Isar 1	870	BWR	1979	100
	Isar 2*	1285	PWR	1988	70
GKN	GKN 1	795	PWR	1976	100
	GKN 2*	1230	PWR	1989	50
HEW	Brokdorf*	771	BWR	1987	0
	Krümmel	1290	BWR	1984	100
KWO	Obrigheim 1	328	PWR	1969	100
Preussenelektra	Würgassen	640	BWR	1972	100
	Stade	630	PWR	1972	100
	Unterweser	1230	PWR	1979	100
	Grohnde	1256	PWR	1985	100
	Brokdorf*	1290	PWR	1986	0
RWE	Biblis A	1146	PWR	1974	100
	Biblis B	1240	PWR	1976	100
	Gundremmingen B	1244	BWR	1984	100
	Gundremmingen C	1244	BWR	1985	100
	Kamlich*	1227	PWR	1986	100
SBK	Kalkar*	295	LMFBR	1987	95
VEW	THTR 300	296	HTR	1985	100
	Emsland*	1290	PWR	1988	50
Total		21,729			

*Unit under construction

BW = Badenwerk AG
BAG = Bayernwerk AG
EVS = Energieversorgung Schwaben AG
GKN = Gemeinschaftskernkraftwerk Neckar GmbH
HEW = Hamburgische Elektrizitätswerke AG
KWO = Kernkraftwerk Obrigheim GmbH
RWE = Rheinisch-Westfälisches Elektrizitätswerk AG
SBK = Schnell Brüter Kernkraftwerksgesellschaft mbH
VEW = Vereinigte Elektrizitätswerke Westfalen AG

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Figure 4

NUCLEAR POWER PLANT OWNERSHIP
IN THE FEDERAL REPUBLIC OF GERMANY

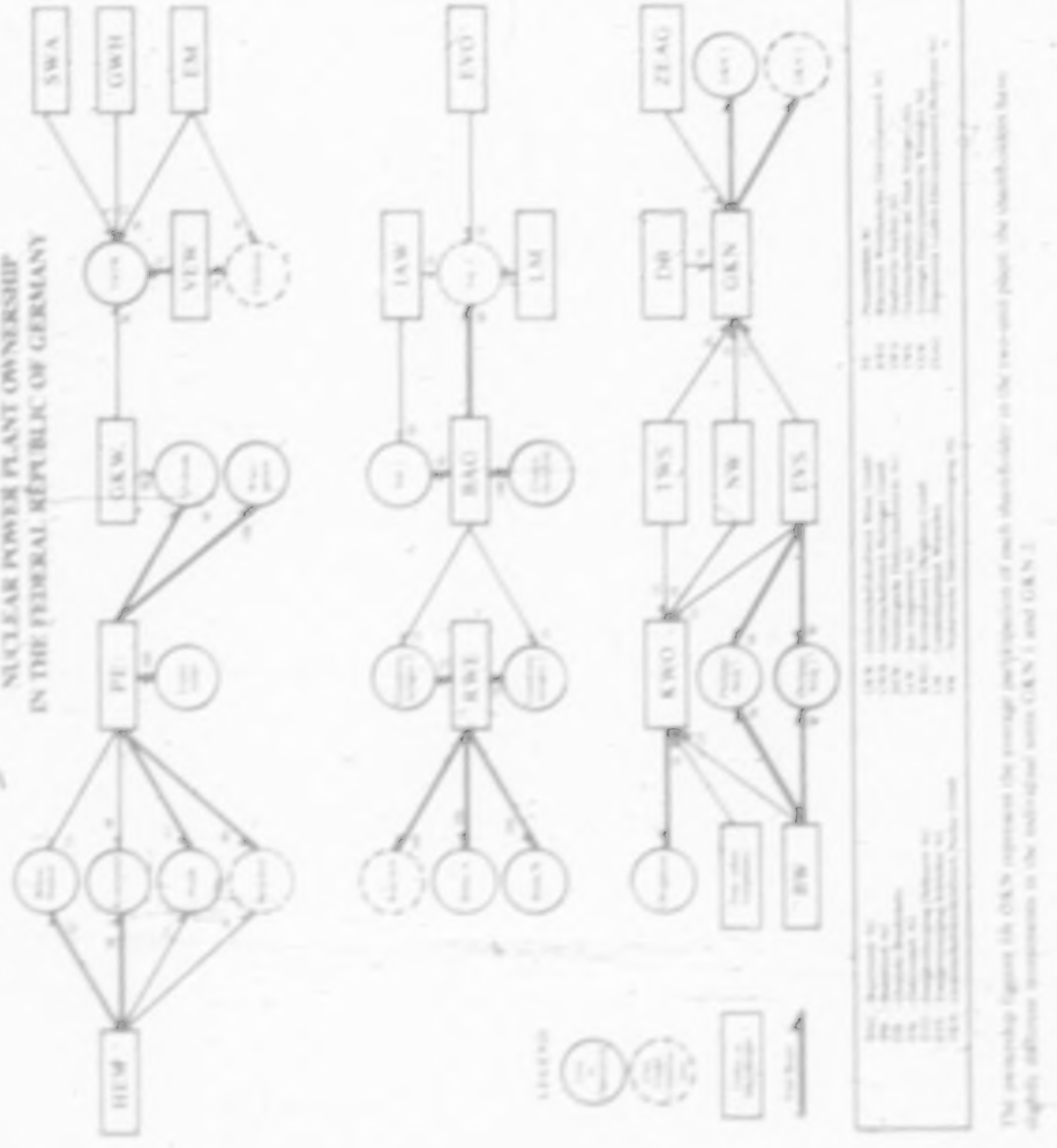
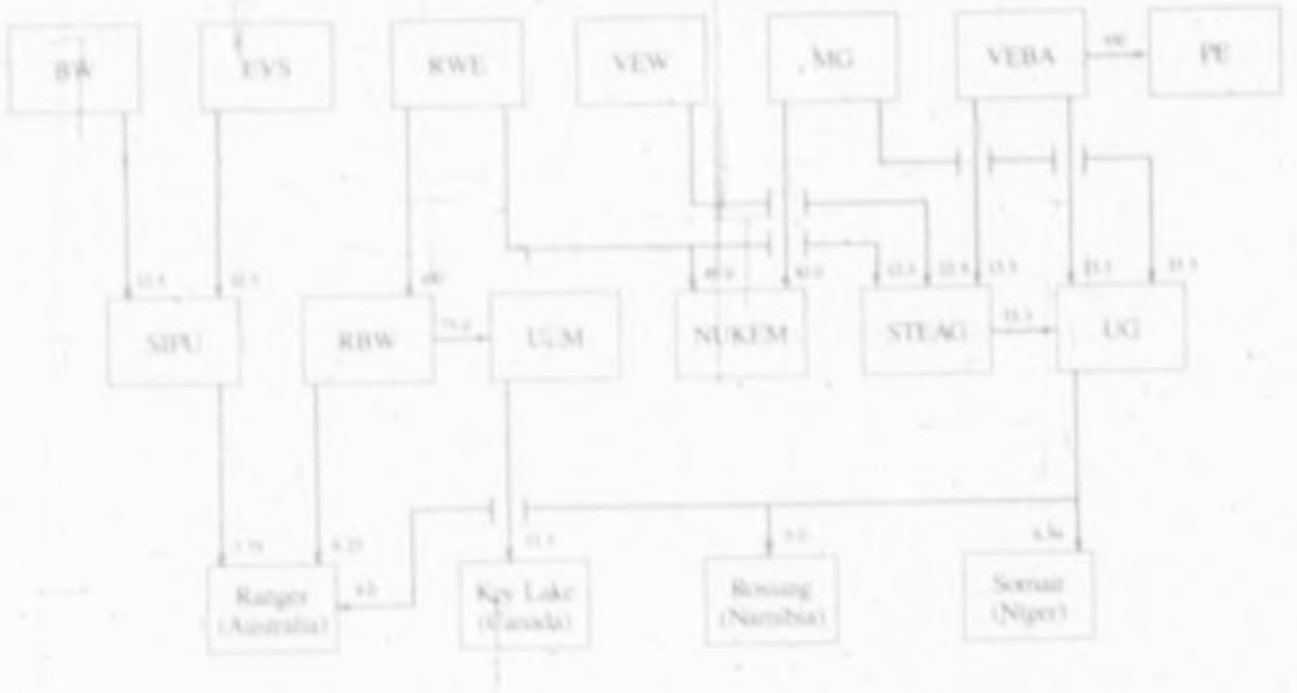


Figure 5

GERMAN OWNERSHIP IN ACTIVE
URANIUM PRODUCTION AND TRADING OPERATIONS



BW — Badenwerk AG
EVS — Energieversorgung Schwaben AG
MG — Metallgesellschaft AG
NUKEM — Nukem GmbH
PE — Preussenelektra AG
RBW — Rheinische Braunkohlenwerke AG
RWE — Rheinisch-Westfälisches Elektrizitätswerk AG
SIPU — Saarberg Interplan Uran GmbH
STEAG — Steag AG
UGM — Urangesellschaft mbH
UG — Urangesellschaft mbH
VEBA — Veba AG
VEW — Vereinigte Elektrizitätswerk Westfalen AG

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EUROPE

ITALY

Until its 1985 ENEL (Ente Nazionale per l'Energia Elettrica), Italy's state utility, made the first concrete step in twelve years toward the expansion of its nuclear power capacity when it signed a contract with Ansaldo Meccanico Nucleare SpA, the Italian reactor supplier, to build two 975-MWe PWRs at the Trino Vercellese site in Piedmont. Civil engineering work is scheduled to begin in mid-1987, and commercial operation dates are planned for 1994. ENEL last ordered a reactor in 1973, when it contracted for the two-unit Montalto di Castro BWR station in Latium, now approximately 40-percent complete and scheduled to enter service in 1990. One 875-MWe BWR, located on the Po River at Caorso near Piacenza, has been in commercial operation in Italy since 1981, and two smaller units, a 260-MWe PWR at Trino and a 150-MWe GCR near Latina, have been in operation since the mid-1960's.

Italy's nuclear power program has a more pronounced history of delays than any other European country, a fact that has influenced the nuclear fuel market over the past several years. To some degree, the delays may be attributable to unrealistic planning by the Italian government. The government's most recent National Energy Plan, passed in 1981, calls for installment of 12,000 MWe of nuclear capacity by 1990, or eleven 1,000-MWe units in eight years. One major cause of delay was public opposition to new plant construction projects. In December 1985, 96 percent of voters in a region of Calabria rejected ENEL's proposal to build a four-unit coal station. Approval in most parts of Italy for nuclear projects has been equally elusive. The utility obtained local backing for the new Trino units mainly for two reasons: the site already has a PWR in operation, and the government offered a number of economic incentives to the region.

ENEL's problems in developing new nuclear and coal stations on a large scale has left it among the business users of fuel oil for electricity production in Europe. The recent dramatic slump in oil prices has made oil-fired plants more acceptable economically, though environmentally they remain unattractive. In fact, ENEL's existing installed generating capacity is adequate to supply all of the country's current electricity needs, and the utility is importing a substantial share of its needs rather than employing all of its capacity. ENEL took advantage of EDF's excess capacity during 1985, receiving more than 6,500 GWh of power from France.

NETHERLANDS

1985 was a long-delayed year for the Dutch electricity sector, as the parliament approved a plan to install at least 2,000 MWe of nuclear generating capacity by 1995. Dutch utilities had been hindered by anti-nuclear politics since the mid-1970s, when a government plan to construct 3,000 MWe of nuclear capacity was shelved due to political controversy. By contrast, opposition to the 1985 decision has been relatively quiet in a country known for its ecologist and pacifist movements. Dutch public opinion, measured in a lengthy survey on energy sponsored by the government and completed in January 1984, still favors "soft" energy sources over additional nuclear or coal plant construction. However, the government expects the country to need between 8,000 and 10,000 MWe in new generating capacity by 2000, a target impossible to reach by adding only renewables and combined heat and power. Thus, in January 1985 the cabinet issued its plan to build new nuclear units. Parliament approved the plan in June, and in January 1986 approved the government's site recommendations for the new units, paving the way to ordering the units.

The government recommended three sites in order of preference: the favored site being Borssele in Zeeland, in the southwest corner of the country, where the Netherlands' largest existing nuclear unit has been operating since 1973. The unit, a 445-MWe Kraftwerk Unions PWR operated by PZEM (Provinciale Zeeuwse Energie Maatschappij), has a successful operating history. (The only other commercial unit in the Netherlands is a 55-MWe BWR located at Dodewaard.) The other sites recommended by the government were at Moerdijk, south of Rotterdam, and near Delfzijl at the country's northern tip. Site selection is scheduled to be completed in April prior to general parliamentary elections in May 1986.

If the station is built at Borssele as expected, a consortium of three southern utilities including PZEM is likely to be the owner-operator. The Netherlands' thirteen provincial utilities have been planning mergers for some time, the effect of which will be to create three or four large utilities, the consortium owning the future Borssele station could become a single utility if the mergers plans are eventually realized. The invitation for bids to build the new units is scheduled for April 1986, while the plant orders and license applications are expected in late 1987.

The Dutch parliament placed one condition on its approval of the nuclear energy plan: that an acceptable solution to the long-term disposal of spent fuel be found prior to the granting of any licenses. Thus, while formalizing their construction plans during the next eighteen months, the utility group will also develop a proposal for closing the fuel cycle in the Netherlands. One other uncertainty remains: if an anti-nuclear political coalition wins the May 1986 parliamentary elections, the parliament could reverse the 1985 decision. The pro-nuclear coalition of Christian Democrats and Liberals currently has a majority of 81 votes in the 150-seat assembly.

PORTUGAL

Empresa Nacional de Uranio's (ENU) uranium mill at Urgeirica produced approximately 300,000 pounds U3O8 during 1985, roughly the same amount as in 1984. ENU currently mills ore from six sedimentary deposits at the northern part of the country. Portugal's reasonably assured uranium resources total nearly 20 million pounds U3O8. Government officials held talks during 1985 with Atomic Energy of Canada Ltd. (AECL) regarding the possibility of building Candu nuclear stations in Portugal. The government apparently favors the Candu over light-water reactors because it uses natural uranium fuel, eliminating the need for foreign enrichment contracts. AECL is scheduled to complete a feasibility report early this year on the construction of up to four units. Portugal joined the European Economic Community on January 1, 1986, bringing the nation's nuclear related activities under the jurisdiction of the Euratom organization.

SPAIN

Two nuclear units entered commercial operation during 1985, increasing total installed nuclear generating capacity in Spain to 5,662 MWe produced by eight units (Table 16 and Figure 6). Cofrentes, a 975-MWe General Electric BWR operated by Hidroelectrica Espanola SA., began commercial generation in March, and Asco Unit 2, an 897-MWe PWR owned by a consortium of four utilities, began service in June. Two additional units, Trillo Unit 1 and Vandellos Unit 2, are under active construction and scheduled to be completed in 1987. After that time, no new units are likely to enter operation before at least the mid-1990s. Construction work on Lemoniz Units 1 and 2 and Valdecaballeros Units 1 and 2, a total of 3,750 MWe of capacity, has slowed considerably since the government announced its national energy plan in 1984 which deems over 30 GWe of new units for at least the next seven years.

Table 16

SPAIN'S REVISED NUCLEAR POWER PROGRAM

Unit	Utility	MWe	Type	COD
Operating				
Jose Cabrera[1]	UE	150	PWR	1968
Garona	Nuclenor	440	BWR	1971
Vandellos 1	Hifrensa	480	GCR	1972
Almaraz 1	HE/CSE/UE/Iberduero	930	PWR	1981
Almaraz 2	HE/CSE/UE/Iberduero	930	PWR	1983
Asco 1	Fecsa/Enher[2]	897	PWR	1984
Asco 2	Fecsa/Enher/HC/FES	897	PWR	1985
Cofrentes	HE	975	BWR	1985
TOTAL		5,662		
Under Construction				
Trillo 1	UE/Iberduero	997	PWR	1987
Vandellos 2	Enher/HC/Enher[2]	982	PWR	1987
TOTAL		1,979		
Indefinitely Deferred				**Percent Complete**
Lemoniz 1	Iberduero	930	PWR	95
Lemoniz 2	Iberduero	930	PWR	90
Valdecaballeros 1	HE/CSE	975	BWR	80
Valdecaballeros 2	HE/CSE	975	BWR	45
TOTAL		3,750		

[1] Also known as Zorita.
[2] Enher is Iberduero interest.

UE = Unigas Electrica Fenosa SA
Nuclenor = Centrales Nucleares del Norte SA
Hifrensa = Hispano-Francesa de Energia Nuclear SA
HE = Hidroelectrica Espanola SA

CSE = Compania Sevillana de Electricidad SA
Fecsa = Fuerzas Electricas de Catalunya SA
Enher = Empresa Nacional Hidroelectrica Ribagorzana SA
HC = Hidroelectrica de Catalunya SA
FES = Fuerzas Electricas del Segre SA

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EUROPE

Figure 6

DISTRIBUTION OF NUCLEAR UNITS AND URANIUM
PRODUCTION AREAS IN SPAIN AND PORTUGAL

The Spanish electric utility industry implemented a restructuring program during 1987 designed by the government to improve efficiency and balance capacity holdings among the principal regional utilities. One of the direct results of the restructuring has been to alter the ownership of several nuclear units, in particular by granting shares in these units to the principal utility in the country's industrial north, Iberduero SA, partly as compensation for capacity it has lost through the shifting of the two-unit Lemoniz plant (Table 17). The state utility Endesa also acquired shares in two nuclear units, while Union Electrica Fenosa divested itself of approximately half of its ownership in the Ascoy plant. Several of the country's plants are owned by utility consortia.

Table 17

RECENT CHANGES IN UTILITY HOLDINGS OF NUCLEAR UNITS IN SPAIN

Unit	Owners in 1985	Percent	Owners in 1986	Percent
Jose Cabrera	UE-Fenosa	100	unchanged	
Garona	Nuclenor	100	unchanged	
	(50% Elec. de Viesgo)			
	(50% Iberduero)			
Vandellos 1	Hidrola	100	unchanged	
	(25% Esther)			
	(25% Fecsa)			
	(25% HC)			
	(25% EDF)			
Vandellos 2	Endesa-Esther	54	Endesa-Esther	75
	HC	29	HC	25
	Segre	10		
	Fecsa	7		
Almaraz 1 & 2	Hidrola	11.1	Hidrola	36
	Sevillana de Electricidad	11.1	Sevillana de Electricidad	36
	UE	11.1	UE	11.1
			Iberduero	11.1
Asco 1	Fecsa	100	Fecsa	60
			Endesa	40
Asco 2	Esther	40	unchanged	
	Fecsa	40		
	HC	17		
	Segre	3		
Cofrentes	Hidrola	100	unchanged	
Trillo 1	UE	80	UE	40.5
	Endesa	20	Iberduero	40.5
			E. Castellonense	7

EDF = Electricite de France
Endesa = Empresa Nacional de Electricidad
Esther = Empresa Nacional Hidroelectrica Ribagorzana
Fecsa = Fuerzas Electricas de Cataluna SA
HC = Hidroelectrica de Cantabrico
Hidrola = Hidroelectrica Española
Hidronor = Hispano Francesa de Energia Nuclear SA
Nuclenor = Centrales Nucleares del Norte
Segre = Fuerzas Hidroelectricas del Segre
UE = Union Electrica-Fenosa

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EUROPE

Spain became a member of the European Economic Community (EEC) on January 1, 1986, and is now part of Euratom, the EEC atomic energy treaty organization. Spain's entrance into the EEC will accelerate economic integration with other European countries, and may increase Spanish participation in European electricity and nuclear energy projects. Currently the Spanish state uranium company Enpsa (Empresa Nacional de Uranio SA) owns 11.11 percent of Eurodif, which includes power from EDF's 3,660-MWe Tricastin station; Spanish utilities are importing power from EDF both in lieu of electricity due at Eurodif and under other contracts. EDF in turn imports power from Spain in accordance with its 25 percent ownership in Vandellos Unit 1, a 480-MWe GCR located near Barcelona.

Enusa produced approximately 500,000 pounds U_3O_8 in 1985 at its Ciudad Rodrigo conventional mill and heap leaching facilities near Salamanca. The company plans to expand domestic production operations over the next several years as foreign supply obligations end and inventories decrease. The general plan to produce 1,000 tons U_3O_8 annually by the early 1990's would lessen foreign expenditures and increase self-sufficiency in the fuel cycle. Spain has reasonably assured uranium resources in excess of 35 million pounds U_3O_8, most of which are concentrated in the province of Salamanca. During 1985 Enpsa purchased natural uranium from Cominak in Niger, of which it is a 10 percent owner, and from Canadian and African producers. Enrichment was supplied by DOE, Eurodif and the USSR. The country's first domestic fuel fabrication plant began commercial assembly at Juzbado in 1985.

SWEDEN

The Swedish nuclear power program reached maturity during 1985 as the country's last two units, Oskarshamn Unit 3 and Forsmark Unit 3, and CLAB, the centralized spent fuel storage facility, all entered commercial operation. Oskarshamn Unit 3 and Forsmark Unit 3 are both 1,050-MWe BWRs supplied by Asea Atom; after weeks of power testing and pre-commercial overhaul, the two units were brought into service together on August 21. CLAB began storage operations on July 11. At the end of 1985 the country's 12 nuclear units were generating approximately 50 percent of Sweden's electricity (Table 18), complementing 50 percent from hydropower. (See Report 196 of December 1984 for an article on Sweden's nuclear power program.)

Table 18

COMMERCIAL NUCLEAR PLANTS IN SWEDEN

Unit	Utility	MWe	Type	COD[1]
Oskarshamn 1	OKG[2]	440	BWR	Feb 1972
Oskarshamn 2	OKG	595	BWR	Dec 1974
Oskarshamn 3	OKG	1050	BWR	Aug 1985
Barsebäck 1	Sydkraft[3]	570	BWR	Jul 1975
Barsebäck 2	Sydkraft	570	BWR	Jul 1977
Ringhals 1	SSPB[4]	750	BWR	Feb 1976
Ringhals 2	SSPB	800	PWR	May 1975
Ringhals 3	SSPB	915	PWR	Apr 1981
Ringhals 4	SSPB	915	PWR	Nov 1983
Forsmark 1	FKA[5]	900	BWR	Dec 1980
Forsmark 2	FKA	900	BWR	Jul 1981
Forsmark 3	FKA	1050	BWR	Aug 1985
Total		9,455		

[1]Actual or expected Commercial Operation Date.
[2]Sydkraft AB owns 36 percent of OKG.
[3]Sydsvenska Värmekraft AB, a subsidiary of Sydkraft AB, is the owner and operator of the Barsebäck plant.
[4]SSPB = Swedish State Power Board.
[5]FKA = Forsmarks Kraftgrupp AB. SSPB owns 54.5 percent of FKA and is the operator and fuel purchaser for the plant.

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CLAB is located at Simpevarp on Sweden's east coast adjacent to the Oskarshamn power station (Figure 7). It is owned by the Swedish waste-management company SKB (Svensk [illegible]konsult AB) and operated by OKG AB, the owner of the Oskarshamn station. Asea Atom designed CLAB (Figure 8) and built it over a period of five years. The facility currently is equipped to store 3,000 MTU, and it could be expanded to hold 9,000 MTU if needed, the equivalent of the spent fuel from all 12 of Sweden's units over 30 years of operation. The actual storage section of the facility is a rock cavern located 30 meters below sea level and is approximately 120 meters long, 21 meters wide and 27 meters high. An elevator transports spent fuel from the receiving plant to the cavern, where assemblies are stored in pools of water. In addition, construction work continued during 1985 on SFR, Sweden's repository for low-level and intermediate-level radioactive waste, located under the sea floor adjacent to the Forsmark power station north of Stockholm. SFR is scheduled for commercial operation in 1988.

Sweden's operating success with nuclear power and its decisive action to close the fuel cycle have effectively countered much of the public opposition to nuclear energy. That opposition was pointedly expressed in a 1980 public referendum that called for the eventual phase-out of nuclear power. In 1981 the Swedish government set 2010 as the year by which all nuclear units would be decommissioned in accordance with the referendum. The phase-out presents a number of difficult economic problems, and

Figure 7

OSKARSHAMN NUCLEAR POWER PLANT

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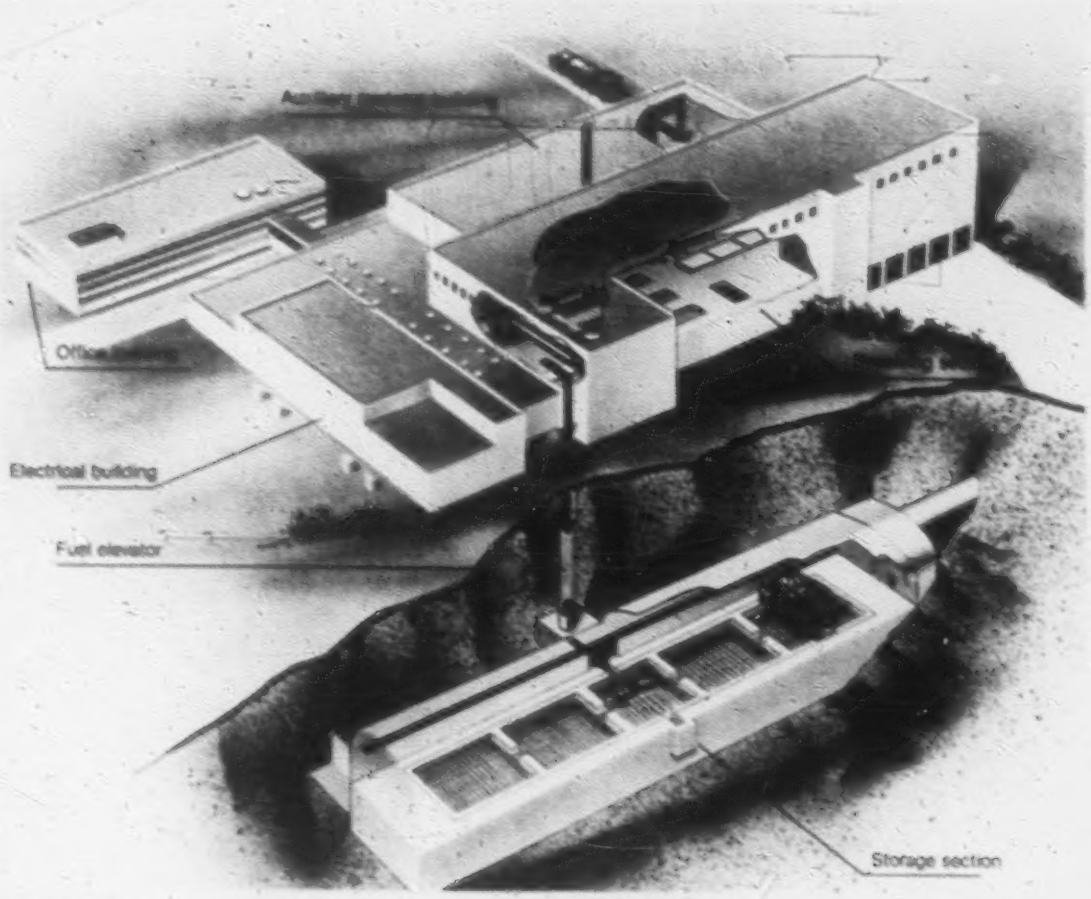
recent opinion polls in Sweden widely reflect the sentiment that either a future government or a future referendum will reverse it.

At the end of 1985 the Swedish State Power Board (SSPB), operator of the four-unit Ringhals station and the three-unit Forsmark station, was close to agreement with Saskatchewan Mining and Development Corporation (SMDC) and Western Mining Corporation of Australia (WMC) for long-term U_3O_8 deliveries beginning around 1990. Western Mining and British Petroleum Australia (BP) are co-owners of the Olympic Dam (Roxby Downs) copper-uranium-gold project in South Australia, currently undergoing development. While no long-term Swedish uranium contracts were reported in 1985, the utilities made some spot purchases. Both SSPB and OKG have signed enrichment contracts with European suppliers in recent years, while Sydkraft, owner of the Barseback station, conferred two requirements contracts to DOE's Utility Services contract in 1984. Barseback Unit 1 was shut down for refuelling in August 1985 after having operated for 371 consecutive days, a European BWR record.

Figure 8

CUTAWAY VIEW OF CLAB FACILITY



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SWITZERLAND

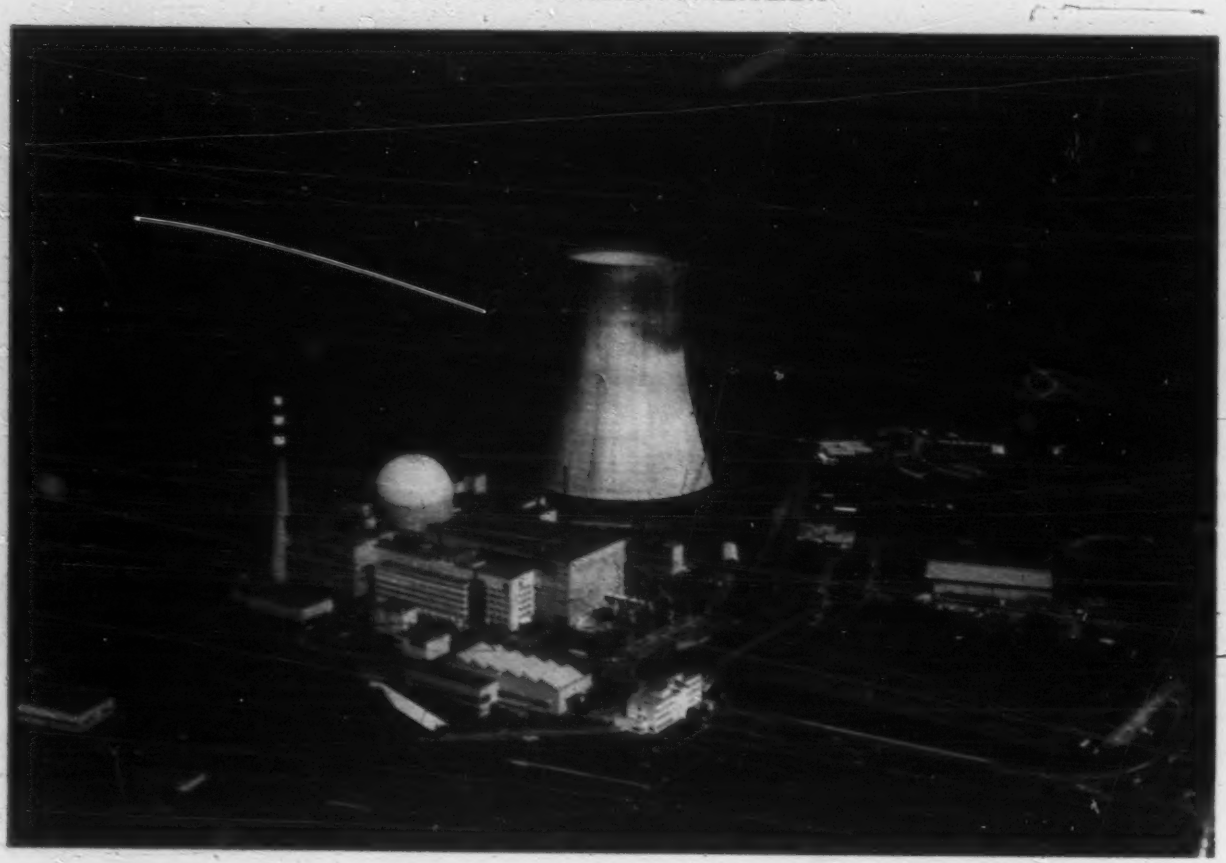
Switzerland's five nuclear power units produced approximately 40 percent of the country's domestic electricity in 1985; most of the balance came from hydroelectric stations. The share of nuclear generation increased substantially over previous years due to the operation of Kernkraftwerk Leibstadt, the 940-MWe BWR that began commercial service at the end of 1984 (Figure 9). Leibstadt was shut down for seven weeks in the summer for replacement of tubing in the condensers, but otherwise operated near full rated capacity all year. Early in 1986, the unit's rating was increased to 1,000 MWe due to excellent operation. Table 19 lists the Swiss nuclear power units.

Following the failure in September 1984 of a public referendum opposing nuclear energy, the Swiss federal parliament in March 1985 approved the need for construction of one new nuclear unit. Since the early 1970s Swiss utilities have planned to build two additional units, Kaiseraugst and Graben. Kaiseraugst was planned before Graben, so it is the unit now undergoing licensing and engineering work following the favorable federal decision. The consortium owning the project includes ten Swiss utilities and engineering groups, Electricite de France, and RWE and Badenwerk of Germany. The plant site is located along the Rhine River on the German border approximately 14 kilometers from Basel, Switzerland's second largest city. Local opposition to the construction of Kaiseraugst is overwhelming in the Basel region; technically, however, the opposition is limited by the fact that the plant site is actually located in the neighboring canton of Aargau, which favors its construction.

During 1985, representatives of the Swiss and Australian governments completed the negotiation of a bilateral uranium

Figure 9

LEIBSTADT NUCLEAR POWER PLANT



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trade agreement, signed in Bern in January 1986. Some Swiss utilities have avoided uranium of North American origin in recent years because of negative experiences with the US and Canadian governments; in that context the pact with Australia increases the number of non-North American uranium sources available to those utilities. Switzerland is not a member of the European Economic Community, and so is not subject to the bilateral agreements between Euratom and non-member countries. Three of the four operating nuclear utilities in Switzerland terminated their enrichment contracts with the US DOE and signed long-term contracts with European enrichers. The most recent such action occurred in the second half of 1985 when NOK (Nordostschweizerische Kraftwerk AG) signed its second contract with Urenco. BKW (Bernische Kraftwerk AG) is the only utility firmly committed to US supplies; it signed a Utility Services contract, and during 1985 accepted DOE's incentive pricing offer.

Table 19

NUCLEAR POWER UNITS IN SWITZERLAND

Unit	Utility	MWe	Type	COD[1]
Operating				
Beznau 1	NOK[2]	350	PWR	Dec 1969
Beznau 2	NOK	350	PWR	Mar 1972
Muehleberg	BKW[3]	320	BWR	Oct 1972
Goesgen	KKG[4]	920	PWR	Nov 1979
Leibstadt	KKL[5]	925	BWR	Dec 1984
Planned				
Kaiseraugst	KWK[6]	925	BWR	indefinite
Graben	KWG[7]	1140	BWR	indefinite

[1]Actual or expected Commercial Operation Date.
[2]NOK = Nordostschweizerische Kraftwerk AG.
[3]BKW = Bernische Kraftwerk AG.
[4]KKG = Kernkraftwerk Goesgen Daeniken AG.
[5]KKL = Kernkraftwerk Leibstadt AG.
[6]KWK = Kernkraftwerk Kaiseraugst AG.
[7]KWG = Kernkraftwerk Graben AG.

UNITED KINGDOM

The UK moved closer to the completion of its Advanced Gas-cooled Reactor (AGR) program in 1985. Heysham Unit A2 and Hartlepool Unit A2 both entered commercial service in the first half of the year, and Dungeness Unit B2 began commercial operation in January 1986, increasing total installed nuclear generating capacity in the UK to 11,748-MWe (Table 20). All three of the new units are owned by CEGB (Central Electricity Generating Board), the state utility in England and Wales. Only four AGRs are still under construction, two at Heysham and two at Torness Point in Scotland, and all are scheduled for service by the end of 1988. Thereafter CEGB plans to construct a series of PWRs on the model of recent Westinghouse plants in the USA.

Sizewell Unit B1, the subject of a two-year public inquiry that finally ended in February 1985, will be CEGB's first PWR. The conclusions of the Sizewell inspector still have not been issued and are not expected until mid-1986. Once issued, the inspector's report will be studied by the government and probably debated in parliament, so it is unlikely that any formal decision on Sizewell can be given before the end of 1986. To date CEGB has invested close to US$300 million equivalent in the project, and is in advanced stages of design work on most parts of the plant. The construction delay actually has helped CEGB's financial situation during the past two years by saving money needed to import fuel oil during the 1984-85 coal miners' strike, and by deferring dollar payments on Sizewell contracts while the pound gains against the dollar. CEGB reported a loss of 1.01 billion pounds in the financial year 1984-85 because of the miners' strike. If approval for Sizewell is granted on a reasonable schedule, CEGB plans to apply for permission to install its second PWR at Hinkley Point.

Installation of the first 1,000-MWe link of a planned 2,000-MWe grid exchange between CEGB and France's EDF was nearly completed during 1985. The link was originally designed to help optimize capacity use in the two countries through power exchanges at different hours of the day. However, it is more likely to become a vehicle for French power exports to the UK from EDF's Gravelines and Paluel nuclear stations on the English Channel. The leaders of France and the UK signed a cooperation agreement in January 1986 to build an undersea train tunnel connecting the two countries, a project that will demand a measure of future power sharing and increase the UK's economic integration with the continent. Both CEGB and the UK Atomic Energy Authority are active participants in various European nuclear energy research projects, notably involving Fast Breeder Reactors.

The British Civil Uranium Procurement Organization (BCUPO), responsible for the procurement of all of the UK's natural uranium needs, reached long-term agreement with two US uranium producers during 1985 and appeared close to agreement with an Australian producer at the end of the year. The two US producers were Energy Fuels and Everest Minerals. BCUPO has begun to diversify away from its traditional uranium suppliers in Southern Africa and Canada. BNFL, the UK's state fuel cycle company, converted approximately 7,500 MTU as UF_6 during the year at its plant in Springfield, a level close to the

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Table 20

COMMERCIAL NUCLEAR UNITS IN THE UNITED KINGDOM

Station/Unit	MWe net per Reactor	Type	Operating Entity	COD	Percent Complete
Calder Hall 1, 2, 3, 4	50	GCR	BNFL[1]	1956	100
Chapel Cross 1, 2, 3, 4	50	GCR	BNFL	1958	100
Berkeley 1, 2	138	GCR	CEGB[2]	1962	100
Bradwell 1, 2	150	GCR	CEGB	1962	100
Hunterston A1, 2	160	GCR	SSEB[3]	1964	100
Trawsfynydd 1, 2	250	GCR	CEGB	1965	100
Hinkley Point 1, 2	250	GCR	CEGB	1965	100
Dungeness A1, 2	275	GCR	CEGB	1965	100
Sizewell A1, 2	290	GCR	CEGB	1966	100
Oldbury 1, 2	300	GCR	CEGB	1968	100
Winfrith	92	HWLWR	UKAEA[4]	1968	100
Wylfa 1, 2	590	GCR	CEGB	1971	100
Dounreay	250	LMFBR	UKAEA	1976	100
Hinkley Point B1	625	AGR	CEGB	1976	100
Hinkley Point B2	625	AGR	CEGB	1977	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	625	AGR	CEGB	1984	100
Heysham A1	625	AGR	CEGB	1984	100
Heysham A2	625	AGR	CEGB	1985	100
Hartlepool A1	625	AGR	CEGB	1984	100
Hartlepool A2	625	AGR	CEGB	1985	100
Dungeness B2	625	AGR	CEGB	1986	100
Total MWe in Operation	11,748				
Heysham B1*	660	AGR	CEGB	1987	85
Heysham B2*	660	AGR	CEGB	1988	75
Torness Point 1*	660	AGR	SSEB	1987	95
Torness Point 2*	660	AGR	SSEB	1988	80
Sizewell B1**	1100	PWR	CEGB	1994	0
TOTAL MWe	15,498				

*Unit under construction.
**Unit on order and undergoing licensing.
[1]BNFL = British Nuclear Fuels Ltd.
[2]CEGB = Central Electricity Generating Board.
[3]SSEB = South of Scotland Electricity Board.
[4]UKAEA = United Kingdom Atomic Energy Authority.

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EUROPE

previous year's figure. The state nuclear fuel company also announced throughput of some 1,200 MTU at the Windscale reprocessing plant in Cumbria. Windscale is adjacent to BNFL's Calder Hall Magnox station, the first commercial nuclear power station in Britain. BNFL is also a one-third owner of Urenco; expansion of Urenco's Capenhurst plant continued during 1985, while much of its SWU production supplied the UK's AGRs (see photo below).

YUGOSLAVIA

Yugoslavia's Krsko nuclear unit, a 615-MWe Westinghouse PWR owned by the Slovenian utility Savske Elektrane (50 percent) and the Croatian utility Elektroprivreda (50 percent), has been operating since December 1981. A consortium of Yugoslav utilities based in Zagreb issued an invitation for bids in October 1985 to build four additional units, and most of the international vendors are evaluating the bid documents. A request for countertrade in Yugloslav goods reportedly is a prominent characteristic of the bid package.

Domestic uranium production from Yugoslavia's Zirovski mine and mill near Ljubljana amounted to approximately 100,000 pounds U_3O_8 in 1985. The Zirovski operation started up in 1984; production is expected to double in 1986, and will be used to supply Krsko. Natural uranium requirements for the unit have been purchased on the spot market for the past few years, and enrichment is supplied by DOE.

The top of a centrifuge cascade in the Urenco centrifuge enrichment plant at BNFL, Capenhurst, England.

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JAPAN

Introduction

The progress made by Japan's commercial nuclear power program in 1985 can be summarized as follows:

1. The private utilities brought into commercial operation five nuclear units with 4,830 MWe generating capacity. As of the end of 1985, 32 nuclear units were operating with a total capacity of 24,521 MWe, approximately 14 percent of the utilities' total generating capacity.
2. For the fourth year in a row, both the average availability and capacity factors of operating plants exceeded 70 percent. The average availability factor was 75.6 percent and the average capacity factor was 74.2 percent, both of which are new annual records. Nuclear plants generated 24 percent of the total commercial electricity generation in 1985.
3. Having solved siting problems in 1984, preparations were begun to build Japan's first commercial scale enrichment, reprocessing, and low-level waste storage facilities at a single location in the northern part of Japan's main island of Honshu. The facilities will be operational in the 1990s and will allow Japan greater self-sufficiency in those services.

Nuclear Plant Status

Figure 10 shows the location of Japan's commercial nuclear plants. Table 21 summarizes the status of the 32 operating units and 16 additional units either under construction or undergoing licensing procedures. Eventual operation for the units in the licensing stage is considered certain, as site selection and preliminary designs have already been approved. Commercial operation dates might be subject to nominal adjustment in order to meet each utility's total generation plans.

The addition of 4,830 MWe to total generating capacity in 1985 established a record annual addition in the 20-year history of Japan's commercial nuclear program. Table 22 lists the annual increase in nuclear generation capacity from 1966 to 1985. Several other records were established in 1985. Tokyo Electric Power Co. (TEPCO) completed Fukushima II Unit 3 in 55 months from start of construction, a domestic record for a 1,100-MWe plant. Also, with the addition of Kashiwazaki Unit 1, TEPCO increased its total nuclear capacity to 9,096 MWe, making it the largest private nuclear utility in the world. Concurrently, Kyushu Electric Power Co. established a Japanese performance record for consecutive days of operation by operating Ikata Unit 2 for 416 days until a scheduled shutdown took place.

The record annual capacity addition in 1985 will probably not be eclipsed within the next decade. Table 21 lists an additional 16 units, with a total capacity of 16,173 MWe, currently under construction or licensing; expected dates of operation extend through 1995. Although three units will approach completion in 1986, they are not expected to reach commercial operation until 1987. Several units not listed in Table 21 are still in the planning stage, and it is doubtful that they will enter commercial operation before 1995.

Table 22

JAPANESE UTILITIES' ANNUAL ADDITION OF NUCLEAR GENERATING CAPACITY
(Gross Megawatts, 1966-1985)

Year	Annual Addition (MWe)	Total MWe at Year-end
1966-75	—	5,278
1976	2,150	7,428
1977	566	7,994
1978	3,508	11,502
1979	3,450	14,952
1980	0	14,952
1981	559	15,511
1982	1,666	17,177
1983	0	17,177
1984	2,514	19,691
1985	4,830	24,521

Installed Capacity Forecasts

The Japanese government, via the Ministry of International Trade and Industry (MITI) and in consultation with the private sector, regularly establishes planning objectives for future electrical generating capacity. In 1985, MITI maintained the following forecast of installed nuclear capacity, first established in 1984:

FY 1990 — 34,000 MWe;
FY 1995 — 48,000 MWe;
FY 2000 — 62,000 MWe.

Nuexco expects that the seven units having commercial operation dates through 1990, totaling 6,959 MWe, will be completed on schedule. This results in a total operating capacity of approximately 31,500 MWe by 1990, slightly below the MITI forecast. The remaining nine units scheduled for operation from 1991 through 1995 (totaling 9,214 MWe), when added to the total expected in 1990, would result in approximately 41,000 MWe capacity by 1995. That is likely to be the maximum because of the constraints on site availability and licensing procedures.

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Figure 10

NUCLEAR POWER PLANTS IN JAPAN

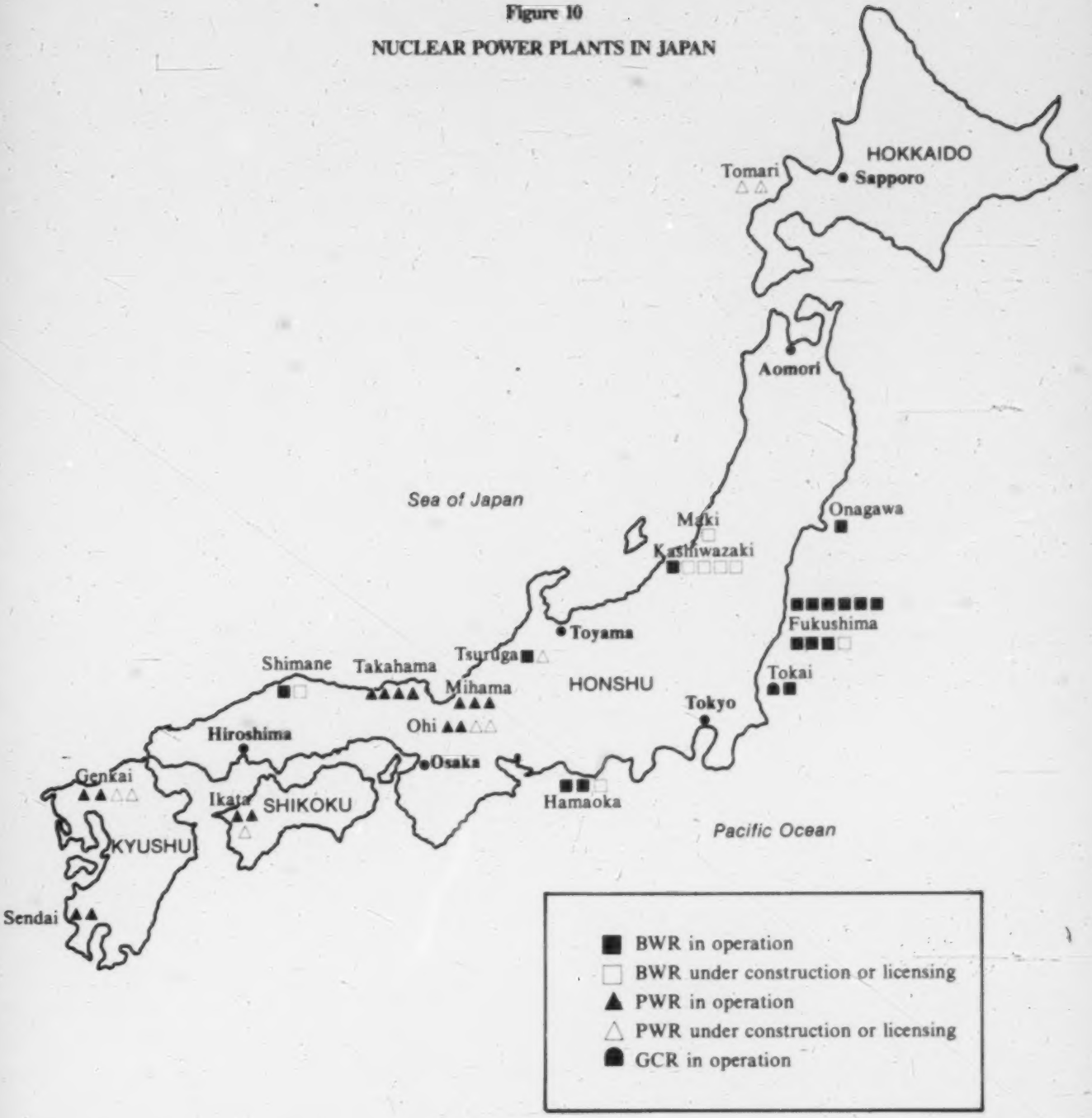

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Table 21

NUCLEAR POWER PLANTS IN JAPAN

Utility	Unit	Capacity (MWe Gross)	Type	COD[1]
Chubu EPC[2]	Hamaoka 1	540	BWR	Mar 1976
	Hamaoka 2	840	BWR	Nov 1978
	Hamaoka 3*	1100	BWR	Sep 1987
Chugoku EPC	Shimane 1	460	BWR	Mar 1974
	Shimane 2*	820	BWR	Feb 1989
Hokkaido EPC	Tomari 1*	579	PWR	Jun 1989
	Tomari 2*	579	PWR	Jun 1991
Japan Atomic Power Company	Tokai 1	166	GCR	Jul 1966
	Tokai 2	1100	BWR	Nov 1978
	Tsuruga 1	357	BWR	Mar 1970
	Tsuruga 2*	1160	PWR	Jun 1987
Kansai EPC	Mihama 1	340	PWR	Nov 1970
	Mihama 2	500	PWR	Jul 1972
	Mihama 3	826	PWR	Dec 1976
	Takahama 1	826	PWR	Nov 1974
	Takahama 2	826	PWR	Nov 1975
	Takahama 3	870	PWR	Jan 1985
	Takahama 4	870	PWR	Jun 1985
	Ohi 1	1175	PWR	Mar 1979
	Ohi 2	1175	PWR	Dec 1979
	Ohi 3**	1180	PWR	Jul 1991
	Ohi 4**	1180	PWR	May 1992
Kyushu EPC	Genkai 1	559	PWR	Oct 1975
	Genkai 2	559	PWR	Mar 1981
	Genkai 3*	1180	PWR	Mar 1993
	Genkai 4*	1180	PWR	Mar 1994
	Sendai 1	890	PWR	Jul 1984
	Sendai 2	890	PWR	Nov 1985
Shikoku EPC	Ikata 1	566	PWR	Sep 1977
	Ikata 2	566	PWR	Mar 1982
	Ikata 3**	890	PWR	Mar 1992
Tohoku EPC	Onagawa 1	524	BWR	Jun 1984
	Maki 1**	825	BWR	1995
Tokyo EPC	Fukushima I-1	460	BWR	Mar 1971
	Fukushima I-2	784	BWR	Jul 1974
	Fukushima I-3	784	BWR	Mar 1976
	Fukushima I-4	784	BWR	Oct 1978
	Fukushima I-5	784	BWR	Apr 1978
	Fukushima I-6	1100	BWR	Oct 1979
	Fukushima II-1	1100	BWR	Apr 1982
	Fukushima II-2	1100	BWR	Feb 1984
	Fukushima II-3	1100	BWR	Jun 1985
	Fukushima II-4*	1100	BWR	Sep 1987
	Kashiwazaki 1	1100	BWR	Sep 1985
	Kashiwazaki 2*	1100	BWR	Oct 1990
	Kashiwazaki 3**	1100	BWR	Jul 1993
	Kashiwazaki 4**	1100	BWR	Jul 1994
	Kashiwazaki 5*	1100	BWR	Apr 1990
Total In Operation		24,521		
Total Under Construction or Licensing		16,173		
TOTAL		40,694		

* Unit under construction.

** Unit undergoing licensing procedures.

[1] Actual or expected Commercial Operation Date.

[2] EPC = Electric Power Company.

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MITI is currently reviewing previous forecasts, and some downward adjustments might be announced in the spring of 1986, in particular for 1995 and beyond. While there is some possibility that several units now in the planning stage could become active projects and begin operation by 1995, most of those units are the first units at new sites, and generally are subject to longer licensing and construction schedules. To date, Japanese utilities have effectively implemented multiple-unit sites, shortening the schedules of the later units.

In the fall of 1985, the Agency of Natural Resources and Energy (a government agency affiliated with MITI), in its annual review of electrical generation costs, determined nuclear generation to be competitive with coal and hydroelectric facilities over the life of the plant (Report 207). Furthermore, it determined that nuclear-generated power has a definite advantage over oil and Liquid Natural Gas (LNG). Subsequently, a significant decline in oil prices combined with a much stronger yen compared to the US dollar has lowered the Japanese utility price for oil under various dollar-based supply contracts. Utility management's perception of the duration of this condition could affect the percentage of power generated by nuclear units, plant construction, and operation schedules for several years.

Uranium Inventories

In the 1970s, the Japanese utilities assured long-term deliveries for an estimated 80 percent of their future uranium needs by contracting with diversified overseas suppliers. Most of these contracts extend through the 1990s. Annual delivery quantities were based on overly optimistic generating capacity forecasts prevalent at the time. The generating capacity at the end of 1985 was only 60 to 70 percent of that forecast five years earlier, at a time when most uranium supply contracts had already started to deliver. Although it is reasonable to assume some adjustments to annual delivery quantities under contract terms, Nuexco estimates that the Japanese utilities took delivery of some 18 to 20 million pounds U_3O_8 during 1985. That total exceeds 1985 estimated requirements by approximately seven million pounds. Moreover, Nuexco estimates that the Japanese utilities collectively hold more than 60 million pounds U_3O_8 in various forms of inventory. This estimate is based on the cumulative total by which deliveries have exceeded actual needs for initial core and reload fuel requirements to date. Most contracts call for annual price renegotiation for the subsequent year's deliveries. Over the next decade, Japanese utilities will continue to receive an average of at least 15 million pounds U_3O_8 per year. That amount exceeds even the annual uranium requirements of the 41,000-MWe program forecast by Nuexco for 1995. Utility uranium inventories will continue to grow until then. 1985 deliveries were based on the negotiated price of $33 to $34 per pound U_3O_8, with some additional small reductions in place for 1986.

Nuexco estimates that as a group, the Japanese utilities are adequately supplied with uranium beyond 1995, based on current inventories and additional future deliveries. Most utilities hold inventories equivalent to 5 to 10 years' forward requirements. As of early 1985, 4 few utilities were thought to have nominal unfilled requirements in the late 1980s. One then signed a long-term contract with Canadian suppliers. Except for the possibility of external events disturbing planned deliveries, the Japanese utilities are not likely to be active in the uranium market for several years.

Enrichment

The major activity concerning enrichment services focused on the implementation of a plan for a domestic enrichment facility. The plan, conceived in 1984, calls for the construction of a 1.5 million SWU per year facility in the northern part of Honshu. Designated as Rokkasho-Mura, the plant site would also contain a reprocessing plant and a central facility for low-level waste storage, to be owned and operated by the utilities.

In March 1985, the utilities, as the major shareholders, organized Japan Nuclear Fuel Industries (JNFI) to own and operate the enrichment facility. Site environmental surveys and preliminary license preparations were initiated. The facility's technology will be based on centrifuge technology developed by the Power Reactor and Nuclear Fuel Development Corporation (PNC). PNC is a quasi-government agency which developed the technology as a national project, primarily with government funding. Arrangements were completed to transfer the centrifuge technology from PNC to JNFI, but commercial terms have not yet been negotiated.

JNFI plans a progressive expansion of the enrichment facility. An initial capacity of 150,000 SWU per year is planned for 1991, followed by an expansion to 1.5 million SWU per year by 1997. Plant hardware will be supplied by Japan's three major nuclear manufacturers; Toshiba, Hitachi, and Mitsubishi Heavy Industries (MHI). These three companies participated as main subcontractors in PNC's previous enrichment development program. In 1985 their joint-venture manufacturing company, Uranium Enrichment Manufacturing Co. (UEM), began construction of a new facility to produce centrifuge machines. Production will start late in 1986.

JNFI's initial plans called for a capacity of 3 million SWU per year at Rokkasho-Mura by the year 2000. That capacity would supply approximately one-third of utilities' estimated annual needs at that time. However, in mid-1985 the USDOE, which will continue to be a major enrichment supplier to Japanese utilities even after completion of the new Japanese facility, announced the cancellation of its Gas Centrifuge Enrichment

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Process (GCEP) program in favor of laser technology. Consequently, the Japanese utilities reevaluated their domestic program based on future technology and related economics. By the end of 1985, the utilities had decided to limit Rokkasho-Mura capacity to 1.5 million SWU per year, and tentatively decided to build another facility, with equal capacity based on laser technology, at a different location. The laser technology is to be developed using a combination of government and private sector funding. Concurrently, DOE officials approached the Japanese utilities for financial support (a reported 2 billion dollars) for the DOE laser development program. In return for financial support, the Japanese utilities would obtain some price concession on future enrichment services from DOE, depending on the interest on funds provided. Negotiations on the matter were continuing as of the end of 1985.

In November 1985, PNC began construction of a 200,000 SWU per year demonstration centrifuge enrichment facility on the western side of Honshu. The plant will act as a technology bridge between the PNC pilot plant (which confirmed PNC's centrifuge technology) and the JNFI commercial-scale plant. Equipment installation at PNC's new plant will commence in late 1986. Annual production of [illegible] SWU is scheduled for 1987 with full capacity could be reached by 1988. UEM will supply the centrifuges. The plant output will serve the utilities' commercial power plants and is estimated to provide enrichment for two reloads annually.

Reprocessing

In 1985, the Japan utilities, via Japan Nuclear Fuel Services (JNFS), continued with plans to build an 800 ton per year reprocessing plant at Rokkasho-Mura. JNFS is proceeding with environmental survey and licensing activities. It will introduce reprocessing technology which is based on technology developed by the French company Fragema. JNFS also concluded basic negotiations whereby MHI, with support from other nuclear manufacturers, would serve as the prime contractor for the new facilities. Prior to this plant's scheduled operation in 1995, JNFS plans to complete by 1991 a storage facility capable of storing 3,000 tons of spent fuel.

PNC will also have an advisory role in the reprocessing facility, having built and operated the 210 ton per year Tokai-Mura demonstration reprocessing plant as part of a national development program. In April 1985, PNC restarted the Tokai-Mura demonstration plant, which has encountered numerous hardware problems since its start-up in 1977. Dissolver corrosion had caused the plant to be shut down since late 1983. PNC reprocessed in excess of 70 tons of spent fuel from the Japanese utilities in 1985. Plans for 1986 include the reprocessing of 140 tons of spent fuel. Technology is similar to that used by JNFS in its commercial plant.

Other Reactors

In October 1985, PNC began construction of its often-delayed 280-MWe Monju Fast Breeder Reactor (FBR). The plant, originally scheduled for operation in 1985, is now scheduled for criticality in October 1992. Present construction cost is estimated to be the equivalent of US$3 billion, a 58 percent increase over the last project estimate in 1979. In November 1985, the nine private utilities announced they would delegate to the Japan Atomic Power Company (JAPC) the development activity for the design of a demonstration FBR to follow the Monju plant. JAPC, owned primarily by the utilities, acts as a vehicle to introduce new commercial reactor concepts. In the past, JAPC built Japan's first gas-cooled reactor as well as the first generation of LWR plants. The electricity produced by those units is sold wholesale to JAPC's owners.

Since 1979 PNC has successfully operated a 165-MWe advanced thermal reactor (ATR), a [illegible] light-water cooled reactor fueled with slightly enriched uranium. The ATR is viewed as a bridge between the present commercial LWRs and future FBRs. In 1985 the Electric Power Development Corporation (EPDC) proceeded with plans to build a 600-MWe demonstration ATR, based on PNC's technology, in northern Honshu. EPDC is a quasi-government wholesale utility which to date has undertaken a large portion of Japan's hydroelectric development projects. EPDC completed preliminary negotiations with local governments and hopes to apply for plant licenses for the ATR in 1986. Construction is tentatively scheduled for April 1989, and the plant could be in operation by 1995. EPDC expects the total cost will exceed the equivalent of US$2 billion.

Both the FBR and ATR are part of a national program established in the late 1960s to reduce natural uranium needs, due to Japan's total reliance on overseas supply of uranium. Initial plans called for the recycling of plutonium and depleted uranium for those reactors by the 1990s. However, the current status of the programs indicate these objectives will not materialize until well into the next century. Japan's commercial LWRs, using enriched uranium, will continue to be the primary basis of nuclear generation for the next several decades.

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FAR EAST

PEOPLE'S REPUBLIC OF CHINA (PRC)

Nuclear Power

The People's Republic of China continued to pursue plans for an ambitious nuclear program. The outline of the program includes the development of nuclear power in eastern and southern provinces with projected generating capacities of 2,000 MWe in 1990 and 10,000 MWe in 2000. Figure 11 shows the location of the 26 provinces in China. Based on the history of development of nuclear power programs in other countries, such a plan involving the operation of 10 to 12 pressurized water reactors (PWRs) by 2000 is quite optimistic.

Chinese experience in nuclear power has been rather limited. In addition to a series of plutonium-generating reactors used for military purposes, the Chinese have operated two small research reactors in Beijing: a 3.5-MWe swimming-pool type unit and a 7-MWe heavy-water reactor later uprated to a greater output. The Atomic Energy Research Institute in Shanghai has conducted research on reactor design, developing prototype reactors for electricity and industrial steam generators. In 1984, a 27-MWe PWR became operational. The next steps in China's nuclear program are likely to be among the following:

1. Officials hope to complete the Qinshan plant, a Chinese-designed 300-MWe PWR near Shanghai. The project will require a number of imported components, including a pressure vessel from Mitsubishi Heavy Industries. The scheduled operation date is 1989.

2. The construction of two PWRs in the Guangdong province, known as the Daya Bay project, is scheduled to begin. The reactor probably will be a Framatome design, and turbines may be supplied by the UK's General Electric Company.

3. Two units are planned for East China, probably near Shanghai. The current plan called for a two-unit station, consisting of 1,000-MWe PWRs. Negotiations were underway with German and Brazilian firms. On March 2, 1986, however, Chinese officials informed the West German reactor supplier Kraftwerk Union (KWU) that negotiations for the purchase of the two units were indefinitely postponed for organizational and financial reasons. Other planned projects include at least three additional stations, each having twin 900-MWe units, located in three different provinces.

It remains to be seen whether the Chinese will be able to commit the huge investment required to complete these projects. A recent report issued by the World Bank concluded that nuclear power in China must compete with low-cost coal and other demands on the nation's financial resources. Thus, for these and other reasons, the successful implementation of all of the planned projects within their projected schedules is not likely to occur.

Uranium Resources

According to official statements, China has enough uranium resources to operate at least 15 reactors for thirty years. With the strong potential for new discoveries in the southeast, China is now considered to be a country with significant uranium resources on an international scale. Total reserves of over 800,000 tons of uranium are possible, and uranium occurrences have been reported in the Xinjiang, Qinghai, Inner Mongolia, Liaoning, Gansu and Guangdong Provinces.

In particular, the Yunnan-Guangxi Plateau is an important area of uranium mineralization in which several large discoveries have been made. In December 1979, officials announced that they had discovered sufficient reserves to support 30 large mines. The deposits are thought to be located near Quantou in southern Guangxi, near the border with the Guangdong Province. In February 1982, the discovery of a series of high-grade deposits in early Tertiary rocks of the Yunnan/Fenghuang area of the Yunnan Province was announced. Uranium deposits in sedimentary rocks also occur in southeast China, in such deposits as Chenhsien in the Hunan Province, and Chaozhping and Taoling in the Guangxi Province.

In the northeast, two significant discoveries have been announced. One of these is a large deposit in the Sanma alkaline massif. The second discovery was made in 1978 at Liaoshangnan, in the Liaoning Province near the Korean border. It is a small deposit, but is of some geological significance in that it bears a similarity to localized deposits in northern Australia.

The Chinese consider these natural uranium resources to be very important in their effort to solicit foreign participation and financial assistance in upcoming industrial expansion. China has been offering uranium for sale on the international market, chiefly to generate opportunities for countertrade. In some cases, nuclear cooperation between China and other nations involves the trading of Chinese uranium.

Nuclear Cooperation Agreements

For the aforementioned reasons, and in an effort toward greater involvement in the world market, China signed several technical and commercial agreements with various countries in 1985.

1. President Reagan signed the USA-China nuclear cooperation pact on December 16, 1985. The joint resolution, passed by both bodies of Congress, requires a presidential certification of China's compliance with non-proliferation policies.

2. In early December, France and China signed an agreement in principle concerning the cost of the two-unit Daya Bay nuclear station in the Guangdong Province, 50 miles northeast of Hong

Figure II
CHINA'S PROVINCES

Kong. The project is a joint venture between the Guangdong Electric Authority and the China Power and Light utility. Under the agreement, Framatome will supply two 900-MWe PWRs and Electricite de France will conduct overall project management.

3. Following the Franco-Chinese agreement, the UK's General Electric Company signed a similar agreement for conventional equipment and turbogenerators at the plant.

4. The West German utility Gemeinshaftskernkraftwerk Neckar GmbH (GKN), was reported to be in negotiations with China for the procurement of natural uranium. The negotiations include such issues as spent fuel and technology countertrade. Reports indicate that uranium prices in the negotiations are competitive with current market prices for uranium contracts. In China's marketing efforts in Germany and Switzerland, Kraftwerk Union has provided assistance, and is trying to establish countertrade opportunities in support of the possible sale of KWU reactors to the Chinese.

5. The Uranium Resources Development Committee (URDC) of Japan indicated it will initiate a joint feasibility study with China for the mining of uranium reserves at Qinglong. Chinese agencies have supplied URDC with preliminary geological data for evaluation. If the study proceeds, a detailed site evaluation will be made over a two-year period to confirm reserves and to plan its development. No information regarding the size or nature of the deposit was released, although the possibility of starting to mine as soon as 1991 was mentioned. To minimize initial investment, labor intensive production methods may be utilized instead of a highly mechanized operation, and current production costs may be less than US$20 per pound U3O8.

THE PHILIPPINES

The only nuclear power plant in the Philippines, Bagac/San Juan Unit 1 (also known as Philippines National Power Plant 1, PNPP-1), had been officially scheduled to begin commercial operation in the first quarter of 1985. However, the issuance of an operating license is still pending. The National Power Corporation (NPC) has filed suit in Manila against Westinghouse over contractual payments resulting from the delay in the issuance of the operating license. In spite of lower oil prices, the delay puts a serious financial burden on the utility, which had anticipated the startup of the 620-MWe, two-loop PWR in 1985.

In recent years, considerable public opposition surrounded the plant's operation, intensifying in the last months of the Marcos regime. Licensing hearings in June 1985 drew large crowds, followed by the sabotage of 13 transmission towers connecting the plant to the capital city of Manila. Immediately prior to her election, President Corazon Aquino stated that the plant, which she considered unsafe, would be scrapped if she was elected. In the first month of her rule, however, no further announcements have been made regarding the future of the plant. The Philippine Supreme Court recently blocked licensing of the plant, ordering that a hearing on safety and other issues be reopened.

Anticipating the eventual commercial operation of PNPP-1, the Philippines National Power Corporation remains in the market for the purchase of uranium. However, the financing terms required by the utility and the perceived risks have not been attractive to potential sellers. NPC on at least two occasions has failed to conclude uranium supply contracts because of financing difficulties.

SOUTH KOREA

In September 1982, the Korea Electric Power Corporation (KEPCO) began commercial operation of its fourth nuclear plant, Ko-Ri Unit 5, located on the southwest coast of Korea (Figure 12). The 895-MWe PWR was supplied by Westinghouse, the turbine-generator by General Electric Co. of Britain, and Bechtel Power Corporation performed the architect-engineering. KEPCO currently operates two PWRs, Ko-Ri Units 1 and 2, and one Candu unit, Wolsung. Five PWRs, three Westinghouse and two Framatome units, are under construction (Table 23).

Later in 1985, following some delays, Korean officials invited nuclear plant vendors, turbine-generator manufacturers, and architect-engineers to bid on Korea Nuclear Units 11 and 12. According to the official plan, the addition of these two units by 1996 will enable Korea's nuclear energy to provide over 43 percent of its total electric power demand. In the bid invitation, Korea will favor competitive bids with an emphasis on technology transfer in order to strengthen its self-reliance in nuclear energy.

Table 23

NUCLEAR POWER UNITS IN SOUTH KOREA

Unit	Plant	MWe	Type	COD[1]	Percent Complete
KNU 1	(Ko-Ri)	556	PWR	1978	100
KNU 2	(Ko-Ri)	605	PWR	1983	100
KNU 3	(Wolsung)	629	Candu	1983	100
KNU 5	(Ko-Ri)	895	PWR	1985	100
KNU 6	(Ko-Ri)	895	PWR	1986	100
KNU 7	(Yeonggwang)	900	PWR	1986	98
KNU 8	(Yeonggwang)	900	PWR	1987	90
KNU 9	(Ul-Jin)	895	PWR	1988	64
KNU 10	(Ul-Jin)	895	PWR	1989	50

[1]Actual or expected Commercial Operation Date

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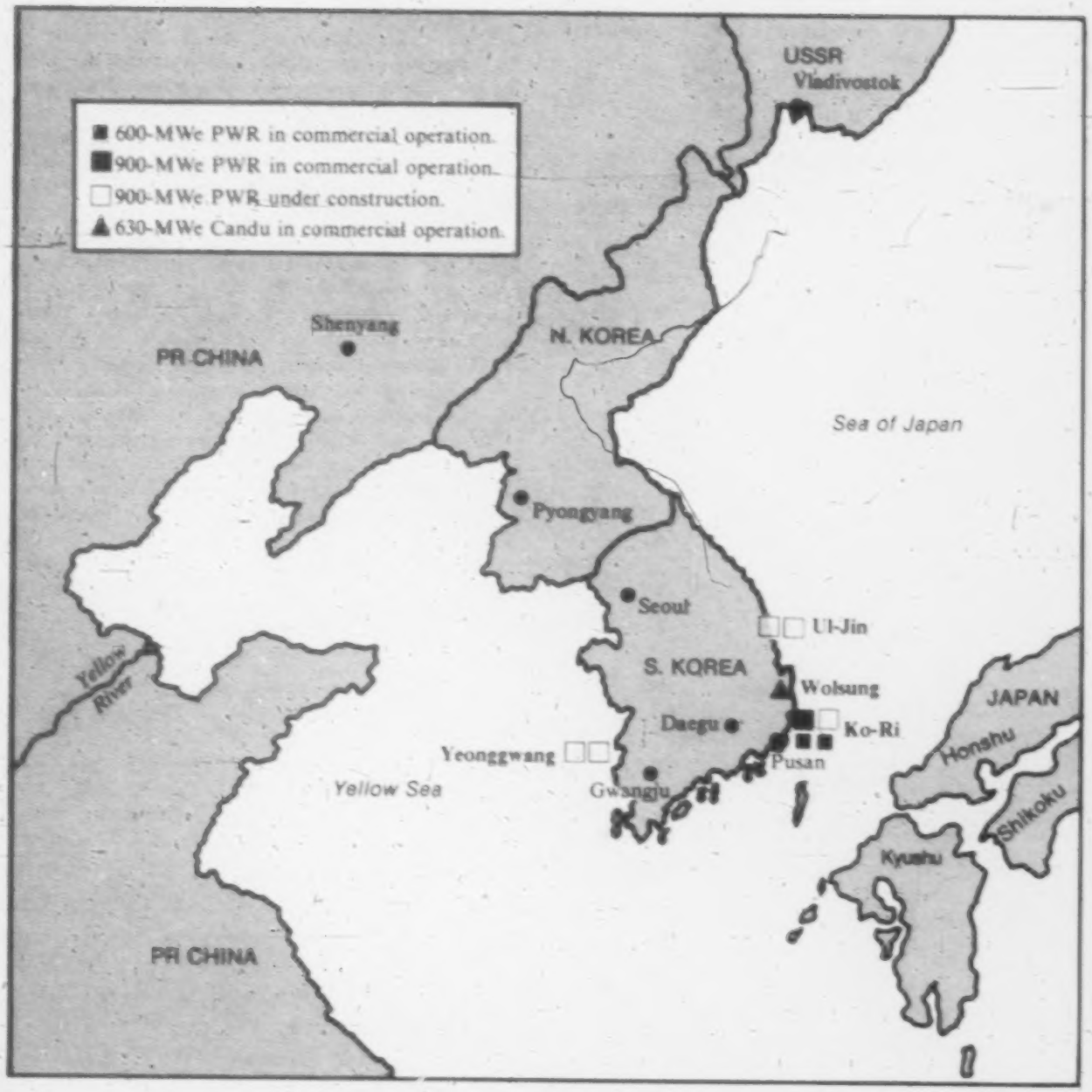
Figure 12

NUCLEAR POWER UNITS IN SOUTH KOREA



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FAR EAST

In general, Korea seeks to increase the degree of autonomy and self-sufficiency in its nuclear program. The Korea Power Engineering Corporation (KOPEC), an engineering subsidiary of KEPCO, is promoting the development of local architect-engineering capability through joint ventures and agreements with overseas companies. KEPCO also manages and partially owns Korea Heavy Industries and Construction (KHIC), and is helping KHIC to localize the construction of all major hardware components by the end of the 1980s. KHIC, as the sole designated Korean manufacturer, is the umbrella licensee to the main supplier companies abroad. KHIC hopes to award subcontracts in the future to smaller Korean companies.

Korea also announced its intent to build its own fuel fabrication plant, which is scheduled to begin commercial production in the 1990s. Kraftwerk Union was recently selected to build the plant at the Daeduk complex near Taejon, south of Seoul. The plant, which officials believe could be completed by 1989, will have a nominal annual production capacity of 200 MTU, and will supply enough fuel for the eight Korean PWRs scheduled to be in operation at that time. Eventually, the plant will be controlled by KEPCO and the Korea Advanced Energy Research Institute (KAERI). Initially KEPCO considered participation by some foreign interests, but the plan was later rejected.

In 1985, KEPCO signed a ten-year enrichment contract with Cogema for thirty percent of the enrichment needs of eight light water reactors in the 1990s. The contract covers three Westinghouse units in operation, three Westinghouse units under construction, and Units 11 and 12, which have not yet been ordered. The contract will supplement an existing contract between KEPCO and Cogema for the enrichment requirements of the Framatome units under construction at Ul-Jin. The balance of enrichment requirements will be provided by the US DOE. KEPCO also signed a uranium contract with Energy Resources of Australia (ERA), under which deliveries are reported to begin in 1991. This contract will supplement an existing arrangement with ERA for uranium supply, and some of the delivery years in the two contracts will overlap.

The future of the Korean nuclear program and the pace of new nuclear plant orders essentially will depend on the growth in electricity demand in Korea. A decision on Units 13 and 14 may be made in 1987. In general, government policy has been based on the desire to achieve a balance between coal and nuclear power for electricity generation, with nuclear power continuing largely as baseload generation.

TAIWAN

When Maanshan Unit 2 began commercial operation on May 18, 1985, Taiwan Power Company (Taipower) had increased the number of operating nuclear plants in Taiwan to six, and had concluded its current nuclear power plant construction program (Table 24). Maanshan Units 1 and 2 are 890-MWe Westinghouse PWRs, located at the southern tip of Taiwan.

At present, there are no plans for additional units in Taiwan. In 1983, Taipower had received bids from General Electric, Westinghouse, Combustion Engineering, Framatome and Kraftwerk Union for the Yenliao project, to be located east of Taipei on the northern coast. The two units would have been 900-MWe reactors scheduled for commercial operation in 1993 and 1994. However, subsequent economic developments, chiefly a lower rate of economic growth, failed to produce the projected electricity demand, so the government did not grant approvals for the project. There had been indications in 1984 that Taipower would revive plans to build the additional units, but some public opposition to the construction and repeated concerns over economic matters delayed a commitment. Again, the program could not gain government approval. Nevertheless, Taipower still plans to install enough nuclear units to account for more than 40 percent of total electricity generation by year 2001.

Similarly, other Taipower projects have experienced some delays. In particular, negotiations for a joint venture agreement between Taipower and Rocky Mountain Energy for an exploration program in the USA were announced in 1984. However, the required government approvals for such an agreement had not yet been released. Taipower is not likely to consider participation in other ventures until a decision is reached regarding additional nuclear units.

Table 24

NUCLEAR POWER UNITS IN TAIWAN

Unit	MWe	Type	COD
Chinshan 1	604	BWR	Dec 1978
Chinsan 2	604	BWR	Jul 1979
Kuosheng 1	948	BWR	Dec 1981
Kuosheng 2	948	BWR	Mar 1983
Maanshan 1	890	PWR	Jul 1984
Maanshan 2	890	PWR	May 1985

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REPUBLIC OF SOUTH AFRICA

Overview

Despite wide-ranging economic and social troubles in South Africa in 1985, the nation's gold and uranium operations experienced another profitable year. In fact, as the South African economy began to lose the confidence and support of the international banking community, the plummeting rand caused prices under contracts denominated in US dollars to soar in rand terms, thereby generating record revenues for gold producers. Once again, record gold prices in rand terms assured a successful year for the uranium industry, since most of the uranium mined in South Africa is extracted as by-product or co-product of gold operations.

Economic Developments

In early 1985, the economy seemed to be emerging from three years of deep recession. But just as interest rates were dropping and economic activity was increasing, the escalation of racial violence caused foreign investors to become anxious about the security of South African investments. The imposition of emergency financial controls and the withdrawal of credit by international banks in mid-1985 brought further pressure on an economy beset by the effects of external political sanctions, whether symbolic, as in the case of President Reagan's Executive Order and the European Community's sanctions, or real, such as divestment (see Report 205 [September 1985] for an analysis of these and other issues). As of the end of the year, South African officials were attempting to reach a settlement regarding the nation's foreign debt crisis. It has been reported that sweeping political reforms are necessary before South Africa's creditors will agree to reschedule some $14 billion of short-term debt.

The reintroduction of the two-tiered exchange rate in September 1985 resulted in the establishment of the financial rand, currently traded at a discount of approximately 25-percent from the commercial rand. The financial rand is chiefly used for foreign trading in South African securities listed on the Johannesburg Stock Exchange. Implemented to stimulate foreign investment, the financial rand was first instituted in the early 1960s, and was abolished in 1983 when the economy was particularly strong. After initially trading at a discount of about 10 percent against the commercial rand, the discount widened to over thirty percent in November and continued to fluctuate. In general, the size of the discount varies inversely according to the degree of foreign confidence in the South African economy.

A short-lived strike in September by members of the National Union of Mineworkers, the country's largest and most powerful black trade union, failed to have a significant impact on uranium production. Only two uranium operations were affected, and the mass firing of striking workers by Gold Fields of South Africa Ltd. broke the strike and discouraged the union, which was short on resources to sustain its members, after three days. The processing of stockpiled ore allowed for the continuance of full output.

Regardless of the problems encountered in 1985, the large stockpiles held by producers will continue to keep uranium supply channels open for the foreseeable future. Moreover, the importance of gold revenues to the South African economy dictates that gold, and therefore uranium, production will certainly continue.

Uranium Production

Total production of 12.2 million pounds U_3O_8 in 1985 represented a 15-percent decline from the 1984 level. The chief reason for this drop was the cessation of mining operations at Beisa and Blyvooruitzicht at the end of 1984. Beisa, which had consistently produced about one million pounds annually, was shut down because of sharply increasing losses. Being a primary uranium producer with gold as a by-product, the mine was unable to rely on gold operations to remain profitable. Blyvooruitzicht, a relatively high-cost producer, ceased uranium production in November 1984. In all, eight producers experienced declines in production totaling about 2.8 million pounds, two-thirds of which was attributed to Beisa, Blyvooruitzicht, and Chemwes. The only significant increase occurred at Buffelsfontein, which produced about 220,000 pounds more than in 1984. Table 25 shows a breakdown of uranium production among the thirteen Chamber of Mines operations in 1985. In general, the South African uranium industry has now shut down its unprofitable plants and has curtailed production so that it matches current contract commitments.

Palabora Mining Company Ltd., which is not a member of the Chamber of Mines, produced 478,000 pounds U_3O_8 in 1985, an increase of approximately 25 percent from the 1984 level. In its latest report to shareholders, however, the company announced that there had been no sales of uranium concentrates in 1985, reportedly because of greatly increased revenues from copper sales.

Specific Comments on Production Operations

Beisa (St. Helena) and **Blyvooruitzicht.** Because of unprofitable operations, the Beisa mine was closed and allowed to flood at the end of 1984. The project had been unprofitable since production began in 1982. The owners have sold 14.5 million rand worth of the project's assets thus far. At Blyvooruitzicht, sales from the stockpile continued during 1985,

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but production ceased in November 1984. Ore stockpiles are sufficient to supply the remaining commitments, which expire in 1987.

Buffelsfontein. Production increased 16 percent at this high-grade mine. In general, the grades have stabilized over the past year, although tonnage has fallen.

Chemwes (Stilfontein). Production fell by almost fifty percent in 1985. This mine's gold resources are running out, but its uranium production continues from the treatment of surface slimes. Chemwes reduced throughput to 60 percent of capacity in 1985 due to reduced current demand, and probably will not increase its uranium production significantly in 1986.

Driefontein Consolidated. Production fell 45 percent, mostly due to decreased throughput and yield. Although grade has declined steadily, this mine is one of the lowest-cost producers in the industry.

East Rand Gold and Uranium Co. Ltd. (ERGO) (Figure 13). This company retreats old slimes (tailings) dams in the East Rand. Production fell more than 50 percent because of decreased throughput, chiefly due to maintenance and repairs to the mill. This was completed in late 1985, and the mill is now operating at full capacity.

Harmony. This mine recorded a small decline in production in 1985, mainly due to the 1984 closure of the Merriespruit plant, one of three plants that Harmony Gold Mining Co. Ltd. operates. No other cutbacks have been announced, however, and uranium revenue improved during 1985.

Hartebeestfontein. Production remained constant in 1985 for this rich mine. Better grades and higher tonnage increased working profits.

Free State Joint Metallurgical Scheme (JMS). Production remained virtually constant in 1985.

Randfontein. Production increased slightly in 1985, as the company is engaged in expansion through the development of the Doornkop gold mine. Although the latest ore reserves show a decline in tonnage and grade, the increased use of efficient mechanized mining should increase output.

Vaal Reefs (Figure 14). The Vaal Reefs/Southvaal complex continued to be the largest producer in South Africa. Despite a 15-percent tonnage increase at the Southvaal area, uranium

Table 25

**REPUBLIC OF SOUTH AFRICA:
1985 URANIUM PRODUCTION[1]
(Thousands of Pounds U_3O_8)**

Operation	First Quarter 1985	Second Quarter 1985	Third Quarter 1985	Fourth Quarter 1985	Total 1985
Beisa (St. Helena)	0	0	0	0	0
Blyvooruitzicht	0	0	0	0	0
Buffelsfontein	401	378	366	428	1,573
Chemwes (Stilfontein)	148	148	160	139	595
Driefontein Consolidated	45	47	51	48	191
ERGO[2]	83	76	92	95	346
Harmony	256	225	225	234	940
Hartebeestfontein	239	222	243	240	944
JMS[3]	314	356	348	310	1,328
Randfontein	291	319	363	371	1,343
Vaal Reefs	1,156	799	1,137	1,059	4,151
Western Areas	150	189	171	178	687
Western Deep Levels	62	57	0	0	119
TOTAL[4]	3,145	2,816	3,154	3,102	12,218

[1]Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.
[2]ERGO = East Rand Gold and Uranium Co. Ltd.
[3]JMS = Free State Joint Metallurgical Scheme.
[4]Columns may not add due to rounding.

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production declined approximately five percent in 1985. Future production could depend on output from the No. 10 shaft in the South lease area.

Western Areas. Production rose slightly at this relatively low-grade mine. The deeper, higher-grade sections of the mine cannot be fully exploited for several more years. In 1986 work will focus on the ore bodies of the Upper Elsburg series, and by the end of 1986 about 20 percent of the ore will be obtained from mechanical mining techniques.

Western Deep Levels. Traditionally a small uranium producer, the company ceased uranium production in the second quarter of 1985. The uranium plant has been converted into a gold treatment plant, commissioned in August at a cost of 35 million rand. The closure will reduce South Africa's annual output by about 400,000 pounds U_3O_8.

Nuclear Power

The Electricity Supply Commission of South Africa's (Escom) Koeberg Unit 2 reached criticality in July, and entered commercial operation in November 1985. Koeberg Unit 1, which had entered commercial service for a short time in 1984 before being shutdown for cooling pipe inspections in January 1985, reentered operation in June 1985. Both of the units are 920-MWe PWRs, supplied by the French companies Framatome, Alsthom-Atlantique and Framateg. The Koeberg station is likely to be the only commercial nuclear-generating power facility in South Africa, as declining growth rates for electricity demand and low coal costs have postponed the need for more nuclear units.

Figure 13. Aerial view of ERGO's uranium production plant in the East Rand.

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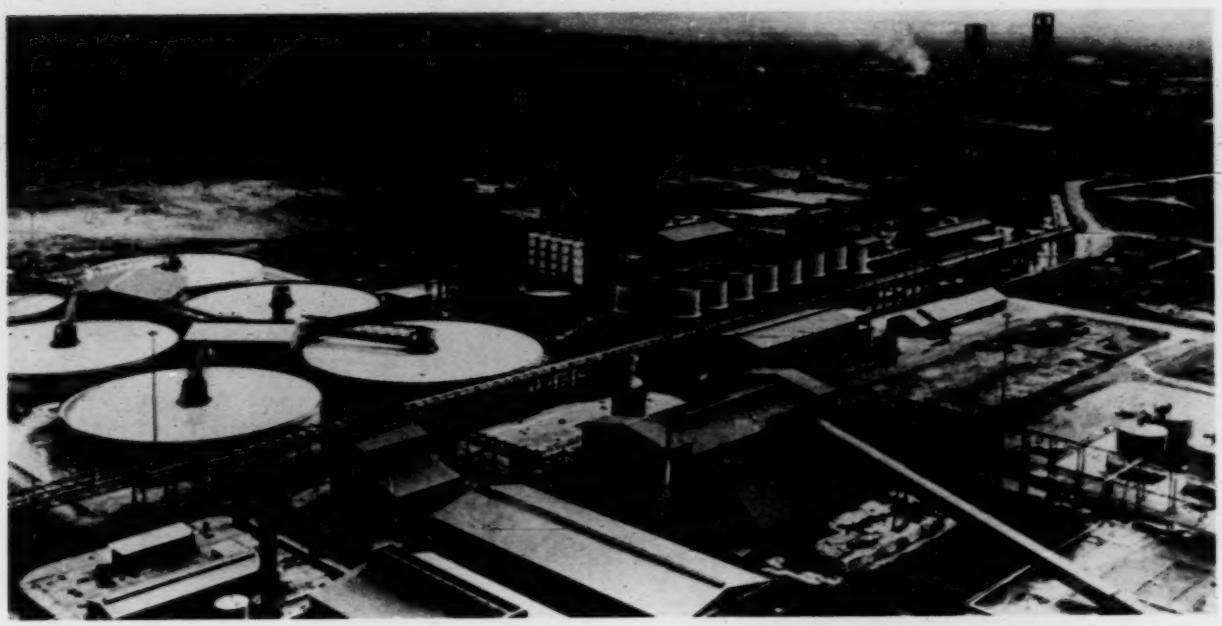
SOUTHERN AFRICA

Figure 14. Aerial view of the Vaal Reefs South uranium production facility.



NAMIBIA

Rossing, the world's largest open-pit uranium mine, is the sole source of uranium production in Namibia. Exact production figures have not been released, but Nuexco estimates that 1985 production totaled approximately nine million pounds U_3O_8, a slight drop from the 1984 level. Nuexco expects production to remain at that level for the immediate future.

The Republic of South Africa, which has retained control over Namibia despite a 1967 United Nations General Assembly mandate establishing the United Nations Council for Namibia as the *de jure* governmental authority, installed what it termed a transitional government in Namibia in June 1985. Shortly thereafter, the Industrial Development Corporation of South Africa (IDC) transferred part of its 13.5-percent ownership interest in Rossing Uranium Limited to the new government. Although the shares total only 3.5 percent of the equity, the shares reportedly account for a majority of the voting rights in Rossing by virtue of their being weighted more heavily than others. The transfer also gave the new government the right to nominate one of the nineteen members of the Rossing board, for the first time giving a Namibian government full access to information on the mine's operations.

Rio Tinto Zinc Corporation retained its controlling ownership interest in the Rossing project and continued as the project's operator, so the ownership transfer caused no operational changes (Table 26). Moreover, the new Namibian government's ties to South Africa signalled a continuation of established policy. The transfer probably stemmed from South Africa's desire to legitimize the new government in the international forum by giving it some economic influence over one of the country's important resources.

Table 26

REVISED OWNERSHIP OF ROSSING URANIUM LTD.

Company	Country	Percent Share
Rio Tinto Zinc Corp.[1]	UK	41.35
Industrial Development Corp.	South Africa	10.0
Total Compagnie Miniere	France	10.0
Rio Algom Ltd.[1]	Canada	10.0
Urangesellschaft mbH	FRG	5.0
General Mining Corp.	South Africa	6.5
Windhoek government	Namibia	3.5
Undisclosed		13.65

[1] RTZ owns 51.3 percent of Rio Algom, so RTZ's net beneficial interest in Rossing is 46.5 percent.

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Nuclear Power

Compared to the past several years, conditions in the US nuclear industry improved considerably in 1985. An indication that 1985 could be termed a transition year for nuclear power in the USA was the fact that no nuclear plants were canceled, an event that last occurred in 1973. In 1984 alone, eight units were canceled. Instead, a total of eight plants began commercial service in 1985, increasing total installed generating capacity to approximately 85,000 megawatts. Nine units received full-power licenses, and four of those attained commercial status (Figure 15). The total number of licensed reactors reached 99, including units having low-power licenses. Table 27 summarizes the licensing progress of US nuclear plants during 1985.

Table 28 lists those units scheduled *by their operating utilities* to attain commercial operation status in 1986, including two units which have already begun commercial service this year. According to the schedules, 18 reactors are expected to enter service in 1986, representing about 18,000 megawatts of installed capacity. Nuexco expects seven of these units will actually achieve that status. Table 29 lists US plant construction progress in descending order of completion percentage as of December 31, 1985. In addition, Nuexco expects that Three Mile Island Unit 1 will reenter the ratebase this year. The unit has been shut down since the 1979 accident at Unit 2.

Although overall spot market purchasing continued at approximately the same level as in 1984, US utility uranium procurement strategies in 1985 placed increased emphasis on long-term contracts. The perception that market prices had reached a low point, combined with the fact that many supply agreements made in the late 1970s had begun to expire, contributed to the increased long-term procurement by US utilities. Most of the US utility contracts concluded or in negotiation during 1985 involved US or Canadian producers. Several utilities reportedly signed contracts with Energy Resources of Australia (ERA) for long-term supply despite the existence of the Australian government floor price, currently about US$30 per pound U_3O_8. Because it is unlikely that US utilities would agree to terms that could require them to buy large amounts of uranium at prices substantially higher than market prices, it is probable that the contracts are in effect call options that allow considerable delivery flexibility. For example, the contracts might stipulate that the utilities may call on ERA for deliveries if and when the spot market price exceeds the Australian floor price.

Political Developments

Two issues dominated the uranium industry in the USA during 1985. The ongoing lawsuit between three US uranium producers and DOE reached a crucial point in September, when a District Court judge ruled in favor of the producers on one count of the lawsuit. Concurrently, US Secretary of Energy John Herrington

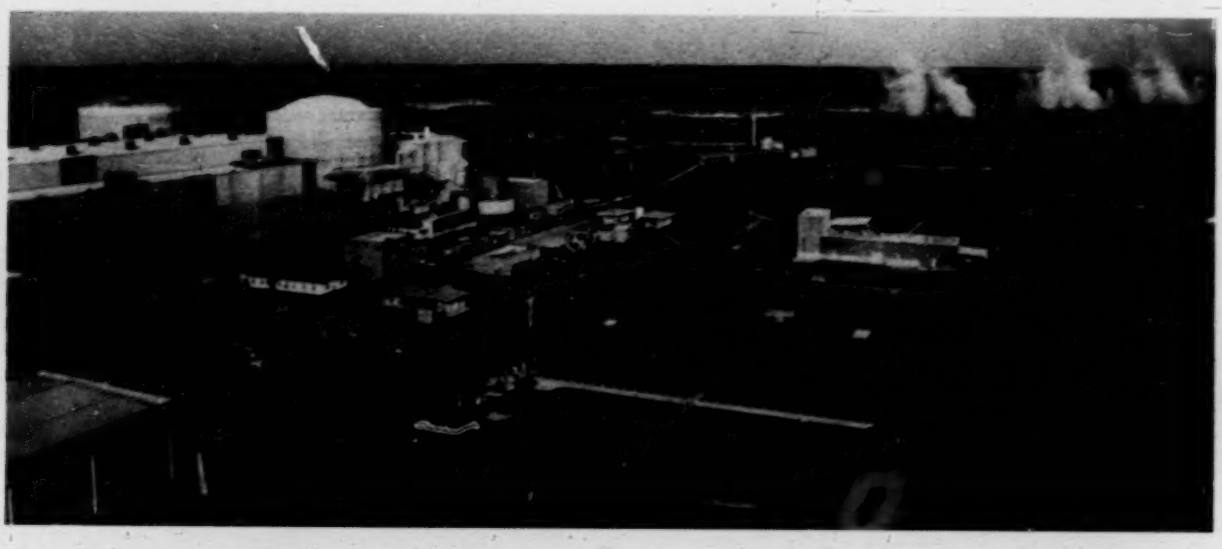

Figure 15. Duke Power Company's Catawba plant, located near Clover, South Carolina. Unit 1, center left, began commercial operation in June 1985. Unit 2, far left, is scheduled for commercial service in 1987, but could enter operation in late 1986.

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declared the US mining and milling industry non-viable, prompting wide-ranging questions regarding the impact of such a declaration.

The invalidation of the USEC, also covered in Report 206 and the *Enrichment* section of this Review, stemmed from Judge Carrigan's ruling on Count II of the five-count civil suit. That Count specifically addressed the validity of the USEC. Other counts in the suit, however, were still under Judge Carrigan's consideration as of early 1986. Several made specific references to uranium supplies.

Count I requested a reimposition of the US embargo on foreign uranium, asserting that DOE is obligated to limit the enrichment of foreign-origin uranium for domestic end-use so as to "assure the maintenance of a viable domestic industry." Although observers anticipated that Herrington's declaration of the non-viability of the industry would expedite a decision on this count, no ruling has been made.

Count V sought judicial validation and enforcement of the principle that the US industry shall be maintained in a condition such that it shall be capable of supplying 100 percent of US requirements at any time, and under any hypothetical scenario for supply disruption.

With the words "I have taken steps to help the miners and millers in this important industry that is currently under a great deal of strain," Energy Secretary Herrington authorized three steps designed to relieve the domestic uranium industry:

1. The US Trade Representative was asked to examine the facts and implications of uranium imports and corresponding foreign trade and policy issues, and will recommend appropriate courses of action.

2. The variable tails assay option (VTAO) will be offered free of charge to utilities committed 100 percent to the USEC over a rolling five-year period. This item was sought under the still-pending Count III of the producers' suit against DOE.

Table 27

US NUCLEAR UNITS' LICENSING PROGRESS DURING 1985

Unit	Utility	MWe Net	Type	COD
Entered Commercial Operation				
Susquehanna 2	Pennsylvania Power & Light	1050	BWR	Feb 1985
Callaway 1	Union Electric	1150	PWR	Apr 1985
Diablo Canyon 1	Pacific Gas & Electric	1084	PWR	May 1985
Catawba 1	Duke Power Company	1145	PWR	Jun 1985
Grand Gulf 1	Mississippi Power & Light	1250	BWR	Jul 1985
Waterford 3	Louisiana Power & Light	1104	PWR	Sep 1985
Wolf Creek	Kansas Gas & Electric	1150	PWR	Sep 1985
Byron 1	Commonwealth Edison	1120	PWR	Sep 1985
TOTAL		9,053		
Received Full-Power License				
Limerick 1	Philadelphia Electric	1055	BWR	Feb 1986
Palo Verde 1	Arizona Public Service	1270	PWR	Feb 1986
River Bend 1	Gulf States Utilities	940	BWR	Mar 1986
Fermi 2	Detroit Edison	1100	BWR	Mar 1986
Diablo Canyon 2	Pacific Gas & Electric	1106	PWR	Apr 1986
TOTAL		5,471		
Received Fuel-Loading, Low-Power Testing License				
Millstone 3	Northeast Utilities	1150	PWR	May 1986
Palo Verde 2	Arizona Public Service	1270	PWR	mid-1986
Shoreham	Long Island Lighting	809	BWR	indefinite
TOTAL		3,229		

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3. DOE's plans to utilize its stockpile as enrichment feed will be postponed for one year. This item was also sought in the producers' suit (Count IV).

One of the reasons given for Herrington's declaration of non-viability was the US mining industry's reported loss of more than $200,000,000 for 1984. That amount was a decline of $240,000,000 from 1983, when the industry reported a net profit and then-Energy Secretary Hodel declared the industry viable. To date, the declaration of non-viability has had no direct effect. The US Trade Representative's subsequent report did not support any corrective action under existing law which would allow for long-term relief. At present, the possibility of a limitation or embargo of non-US-origin uranium seems unlikely in view of the Reagan Administration's anti-protectionist stance. Workers in larger industries such as steel and automobile manufacturing have been denied similar relief. Moreover, most US utilities oppose any type of embargo.

Closely tied to these issues is the problem of mill tailings cleanup legislation, which will continue to be the subject of deliberations in 1986. While US producers still active in the uranium production business are probably most concerned with the prospect of an embargo on the importation of non-US uranium, many producers that were forced to shut down their operations are primarily interested in the outcome of mills tailing legislation.

Table 28

US NUCLEAR UNITS NEARING COMPLETION IN 1986

Unit	Utility	Net MWe	Type	COD
In Commercial Operation				
Limerick 1	Philadelphia Electric	1055	BWR	Feb 1986
Palo Verde 1	Arizona Public Service	1270	PWR	Feb 1986
Scheduled for Commercial Operation				
River Bend 1**	Gulf States Utilities	940	BWR	Mar 1986
Fermi 2**	Detroit Edison	1100	BWR	Mar 1986
Diablo Canyon 2**	Pacific Gas & Electric	1106	PWR	Apr 1986
Millstone 3*	Northeast Utilities	1150	PWR	May 1986
Shoreham*	Long Island Lighting	820	BWR	1986
Palo Verde 2*	Arizona Public Service	1270	PWR	mid-1986
Perry 1	Cleveland Electric	1205	BWR	Jun 1986
Clinton 1	Illinois Power	933	BWR	Jul 1986
Hope Creek 1	Public Service E & G	1070	BWR	Sep 1986
Byron 2	Commonwealth Edison	1120	PWR	Oct 1986
Braidwood 1	Commonwealth Edison	1120	PWR	Oct 1986
Seabrook 1	New Hampshire Yankee	1150	PWR	Oct 1986
Nine Mile Pt 2	Niagara Mohawk	1085	BWR	Oct 1986
Shearon Harris	Carolina Power & Light	900	PWR	late 1986
Watts Bar 1	Tennessee Valley Authority	1177	PWR	1986
Three Mile Island 1[2]	General Public Utilities	819	PWR	1986
TOTAL		16,965		

*Indicates the unit had a low-power license as of the end of 1985.
**Indicates the unit had a full-power license as of the end of 1985.
[1]Data from published sources.
[2]Three Mile Island Unit 1 is scheduled to reenter the ratebase in 1986.

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Table 29

US NUCLEAR UNITS UNDER CONSTRUCTION AND ON ORDER

Unit	Utility	Net MWe	Type	Percent Complete	COD
Fermi 2	Detroit Edison	1100	BWR	100	Mar 1986
Shoreham	Long Island Lighting	809	BWR	100	indefinite
Diablo Canyon 2	Pacific Gas & Electric	1106	PWR	100	Apr 1986
River Bend 1	Gulf States Utilities	940	BWR	100	Mar 1986
Palo Verde 2	Arizona Public Service	1270	PWR	100	mid-1986
Perry 1	Cleveland Electric	1205	BWR	100	Jun 1986
Hope Creek 1	Public Service E & G	1070	BWR	100	Sep 1986
Catawba 2	Duke Power Company	1145	PWR	100	Jun 1986
Millstone 3	Northeast Utilities	1150	PWR	99	May 1986
Commanche Peak 1	Texas Utilities	1150	PWR	99	Jul 1987
Watts Bar 1	Tennessee Valley Authority	1177	PWR	99	1986
Palo Verde 3	Arizona Public Service	1270	PWR	99	mid-1987
Clinton 1	Illinois Power	933	BWR	98	Jul 1986
Nine Mile Point 2	Niagara Mohawk	1085	BWR	95	Oct 1986
Seabrook 1	Yankee (New Hampshire)	1150	PWR	95	Oct 1986
Shearon Harris	Carolina Power & Light	900	PWR	94	late 1986
Beaver Valley 2	Duquesne Light Company	833	PWR	90	Aug 1987
Braidwood 1	Commonwealth Edison	1120	PWR	90	Oct 1986
Vogtle 1	Georgia Power Company	1100	PWR	89	Jun 1987
Watts Bar 2	Tennessee Valley Authority	1177	PWR	85	Apr 1988
South Texas 1	Houston Lighting and Power	1250	PWR	83	Dec 1987
Bellefonte 1	Tennessee Valley Authority	1213	PWR	83	1995
Byron 2	Commonwealth Edison	1120	PWR	82	Oct 1986
Comanche Peak 2	Texas Utilities	1150	PWR	78	Dec 1987
WPN 3	Washington PPSS	1240	PWR	75	indefinite
South Texas 2	Houston Lighting and Power	1250	PWR	65	Jun 1989
WPN 1	Washington PPSS	1250	PWR	63	indefinite
Braidwood 2	Commonwealth Edison	1120	PWR	59	Dec 1987
Perry 2	Cleveland Electric	1205	BWR	57	indefinite
Bellefonte 2	Tennessee Valley Authority	1213	PWR	54	1996
Vogtle 2	Georgia Power	1100	PWR	53	Sep 1988
Grand Gulf 2	Mississippi Power & Light	1250	BWR	33	indefinite
Limerick 2	Philadelphia Electric	1055	BWR	31	Oct 1990
Seabrook 2	Yankee (New Hampshire)	1150	PWR	23	indefinite
Carroll County 1*	Commonwealth Edison	1120	PWR	0	2001
Carroll County 2*	Commonwealth Edison	1120	PWR	0	2002

*Indicates unit is on order

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Production, Exploration and Development

The decline of activity in all phases of the uranium production industry continued through its fifth consecutive year. Active and potential producers are still waiting for higher market prices and industry stability. Nevertheless, only a rapid and sizeable market recovery will end the debate over the industry's viability. The Exchange Value low of $14.25 in April acted as a trigger for further producer recession; several companies responded almost immediately by relegating their projects to standby or shut-down status. By the end of the year, exploration and mining levels had fallen below those in 1950.

Nuexco estimates production from all sources in 1985 to be approximately 11.1 million pounds U_3O_8, down from 14.9 million pounds in 1984. Nine conventional mills were in production during January, but only three operated throughout the year; the other six mills were taken out of service before mid-year. Two mills were started-up in the fourth quarter, one of which was again placed on stand-by at the end of the year. Approximately 5.4 million pounds U_3O_8 were produced at conventional mills, about 3.3 million pounds were produced from phosphate production, and the remaining concentrates came from solution and heap-leach mining. Table 30 gives the operating status of conventional mills throughout 1985.

Project Activity

Nuexco estimates 1985 exploration and development drilling to be 1.8 to 2.0 million feet, the lowest level since 1950. The surface drilling rate has now declined for the seventh consecutive year (the all-time high was 47 million feet drilled in 1978). Exploration geologists were active primarily in northern Arizona, but also carried out some limited work in the following areas:

— Live Oak, Duval and Kleberg counties of the South Texas district;
— northwestern Nebraska;
— three Tertiary basins in Wyoming; and
— southeastern Utah.

Success was primarily limited to significant high-grade mineralization discovered in breccia pipes located in northern Arizona. Discoveries in other areas were mostly confined to extensions of known deposits and projections along mineral and structural trends. These discoveries generally have a lower uranium content, but are important in sustaining industry activity in the particular area.

The past exploration successes in northern Arizona resulted from extraordinary effort on the part of active companies. At present there are at least four major mining companies, plus approximately 16 small companies and independent operators, exploring in the district. Each employs its own techniques to discover uranium associated with solution-collapse structures in Permian and Mississippian sediments. Not all of the companies have enjoyed exploration success; in fact, only Energy Fuels Nuclear, Inc. has announced recent discoveries. Pathfinder Mines Corporation and Rocky Mountain Energy Company have implemented aggressive exploration programs which may have resulted in limited success, although neither company made an announcement to that effect.

About five companies conducted new exploration projects in the South Texas district in 1985. Drilling was concentrated on targets in the Goliad Formation, where past experience indicates the greatest potential for large, high-grade deposits. In addition,

Table 30

1985 OPERATING STATUS OF CONVENTIONAL URANIUM MILLS IN THE USA
(O = Operating, S = Stand-by)

Company	Jan.	Jul.	Dec.	Location
Bear Creek Project	O	O	O	Powder River Basin, WY
Chevron Resources Co.	O	S	S	Hobson, TX
Conter Corp.	O	S	O	Canon City, CO
Homestake Mining Co.	O	S	S	Grants, NM
Pathfinder Mines*	O	S	S	Gas Hills, WY
Pathfinder Mines	O	O	O	Shirley Basin, WY
Petromerics Corp.**	O	S	S	Shirley Basin, WY
Quivira Mining Co.	O	S	S	Grants, NM
Rio Algom Corp.	O	O	O	La Sal, UT
Union Carbide & Energy Fuels	S	S	O	Blanding, UT

*Closed for expiration
**Decommissioned in 1985.

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Oxidized ores have proven conducive to solution mining techniques. Favorable oxidized mineral trends were explored in Duval, Brooks and Kleberg counties. Activity continues along the known trends in the Oakville Sandstone, primarily in Live Oak and Bee counties, but to a lesser degree. No announcements of important new discoveries were made in 1987.

Mining activity throughout the district was at its lowest level in about seven years. Chevron Minerals Corporation stopped mining the district's only conventional open pit mines and acid mill and began pit reclamation in April. Milling operations ended in June. Chevron controls additional reserves in the general vicinity of the mill site. The future status of the mill is probably dependent upon a tentative development schedule of these reserves. There are five operating solution mines in the district, down from ten in 1982:

1. Mobil Corp., mining the Holiday-O'Meara deposit near Bruni.

2. Intercontinental Energy Corp. (IEC), mining the Zamzow deposit at Three Rivers.

3. US Steel Corp., mining both the Clay West and Burro Ranch deposits near George West.

4. Chevron Minerals Corp., mining the Mt. Lucas deposit, in southern Live Oak County.

5. Chevron Resources Corp., mining the Palangana Dome in Duval County. Production potential from the five properties is about 3.8 million pounds annually, but 1987 production totaled an estimated 1.8 million pounds. US Steel remains the largest single producer in the district.

In Nebraska, exploration activity was limited to three or four companies, all active in Dawes and Box Butte counties in the northwest corner of the State. No new discoveries were announced. Therefore, the Crow Butte project, controlled by the Wyoming Fuels Co./Power Exploration Co. joint venture, remains the only uranium deposit under consideration for development within the state. A pilot plant for testing the feasibility of solution mining is under construction at Crow Butte. The 100-gallon-per-minute plant is scheduled to be operating by mid-1988. Two 5-spot well patterns are in place and ready for operation to determine favorable well pattern design and [illegible] plant leach technology. The leach test program will continue for approximately 12 months, followed by an additional four to six months testing to demonstrate formation restoration procedures. Upon completion of a successful pilot test, the joint venture will be capable of commercial production.

Exploration and development activities in Wyoming were limited to the Powder River Basin, Gas Hills and Shirley Basin. In the Powder River Basin, Uranerz Minerals Corp. continued to test portions of the Highland ore deposit for solution mining in anticipation of moving up in the near future to commercial production. The Central Electricity Generating Board (CEGB) of Great Britain purchased the Lucas/Berger property, located in the southern part of the basin, in August. The property is a potential in-situ leach (ISL) uranium [illegible] permits are already in place as a result of a successful pilot ISL program conducted in 1987.

Malapai Resources acquired the remaining 50 percent interest in the Christensen Ranch property from Western Nuclear Inc., and secured a two-year option to purchase the Irigaray property and ISL plant from Westinghouse. Preproduction [illegible] is progressing to initiate solution mining studies on both properties, possibly beginning in mid-1988. Furthermore, Malapai has tentatively scheduled commercial production from at least one of several potential ore deposits on the properties in late 1987 or early 1988. At present the only sustained production in the Powder River Basin is from two small solution mining operations by Sequoyah Fuels Corp. The recovery centers are part of the Bill Smith property, which was originally developed as an underground mine in the late 1970s.

Pathfinder Mines is the only operator in the Gas Hills and Shirley Basin regions. In March, the Gas Hills mill was closed for renovation prior to the continuation of mining at the Lucky Mc mine and any new projects that may be scheduled for future development. In December, Pathfinder also acquired a property controlled by Petrominerals, suggesting that an additional ore source will be available to sustain operations at the Shirley Basin mill.

The October 1 reopening of the Union Carbide/Energy Fuels White Mesa mill located near Blanding was the high point of activity in southeastern Utah. The mill is processing stockpiled ore from Energy Fuels' three Black Canyon mines and the Pigeon mine. Additional ore is trucked from the mines in northern Arizona to the mill, a distance of over 300 miles. The mill is scheduled to continue operation through 1988.

The Rio Algom mill in La Sal, Utah continued operation throughout the year in order to increase the ore supply. Rio Algom purchased custom ore from independent miners. The opportunity to sell ore slightly supplemented the local industry; seven mines were reopened and new project evaluation was [illegible] in some cases. Rio Algom is now scheduling operations throughout 1988.

In the same district, Minatome City satisfied annual assessment requirements by drilling exploration adits into several ore deposits to establish ore body characteristics and obtain bulk samples for metallurgical testing. The ore deposits are now ready for mining should Minatome decide to move ahead with its uranium program. The several hundred tons of ore mined were processed at the nearby Rio Algom mill.

Events that further affected the US uranium industry in 1987 are listed chronologically in Table 3.

Table 31
1985 URANIUM-RELATED ACTIVITIES IN THE USA

UNITED STATES

Month	Organization	Event or Announcement
Jan	Quivira Mining Co.	Announced full stand-by status for all mines and mill within next few months, Grants, New Mexico.
Jan	Western Nuclear, Inc.	Shutdown Ruby Lake Mine, Grants, New Mexico.
Jan	Homestake Mining Co.	Mill restart after 3-month down period, Grants, New Mexico.
Jan	Rio Algom Corp.	Shutdown Mi Vida mine, La Sal, Utah. 4Q
Feb	Chevron Resources Co.	Announced plan to re-open Mt. Taylor mine for 12-month period of engineering and economic evaluation, Grants, New Mexico.
Feb	Cotter Corp.	Mill placed on stand-by, Canon City, Colorado.
Feb	Western Nuclear, Inc.	Announced intent to sell all uranium properties.
Mar	UNC Resources Corp.	Announced intent to dispose of all uranium properties.
April	Homestake Mining Co.	Announced suspension of milling and cutback on all mine activity, Grants, New Mexico.
April	Anaconda Mining Co.	Announced plan to sell all uranium properties.
May	US Government	Legislation for a $1 billion fund to clean up active uranium tailings piles in US sent to Congress.
June	Texaco Minerals Co.	Decommissioning of Petromerics mill underway, Shirley Basin, Wyoming.
June	Rocky Mt. Energy/ Mono Power, Inc.	Announced termination of joint venture agreement for all uranium projects, including the Bear Creek project, Powder River Basin, Wyoming, effective 7-1-85.
June	Amoco Minerals Co.	To transfer all mineral projects to Cyprus Minerals Corp., 7-1-85.
June	Uranium Producers of America	Filed suit against DOE regarding uranium enrichment policies.
July	Anaconda Mining Co.	Announced intent to sell entire mining company.
Aug	State of Wyoming	Filed "friend of the court" brief before US District Court in support of UPA lawsuit regarding DOE's uranium enrichment policies.
Sep	Homestake Mining Co.	Closed mill and reduced mining to two crews and recovery from mine waters, Grants, New Mexico.
Sep	Energy Fuels Nuclear	Entered exploration joint venture with CEGB, Arizona Strip district.
Sep	State of New Mexico	State and DOE agreed on procedure for stabilizing the Phillips/UNC tailings; first such agreement ever for the industry.
Sep	US DOE	Declared US uranium industry to be nonviable.
Oct	Conoco, Inc.	Concluded ISL production and began full restoration, Trevino project, Hebbronville, Texas.
Oct	Cotter Corp.	Start-up of mill at Canon City, Colorado.
Nov	Uranium Resources, Inc.	Resubmitted mining application to the Texas Water Commission for the Kingsville Dome project, near Kingsville, Texas.
Dec	Minatome Corp.	Entered exploration joint venture with Concord Oil Corp. on property in vicinity of Palangana Dome, Duval County, Texas.
Dec	Cotter Corp.	Closed mill after 3-month run, Canon City, Colorado.
Dec	Quivira Mining Co.	Request made to Bureau of Land Management for stand-by status of Church Rock mines in final review. If granted, mines will be sealed and allowed to flood.

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